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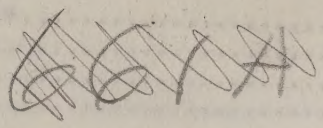
INSTRUCTION BOOK



The Sona-Graph

Copy to
Art Henderson
MKS 23-85
2-4872

KAY ELECTRIC COMPANY

PINE BROOK, N. J.

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CApital 6-4000

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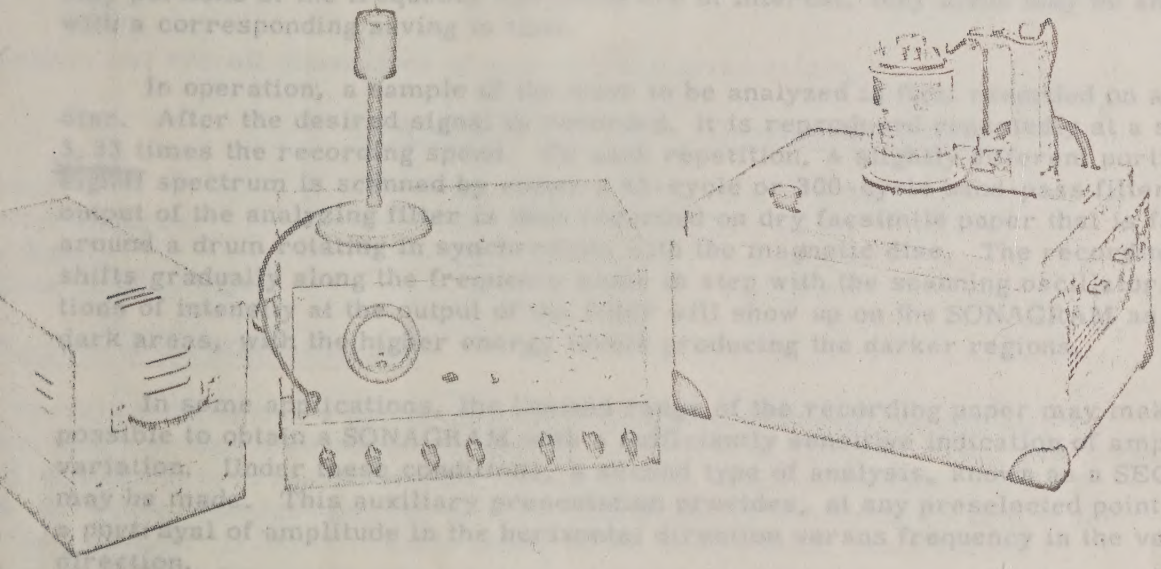
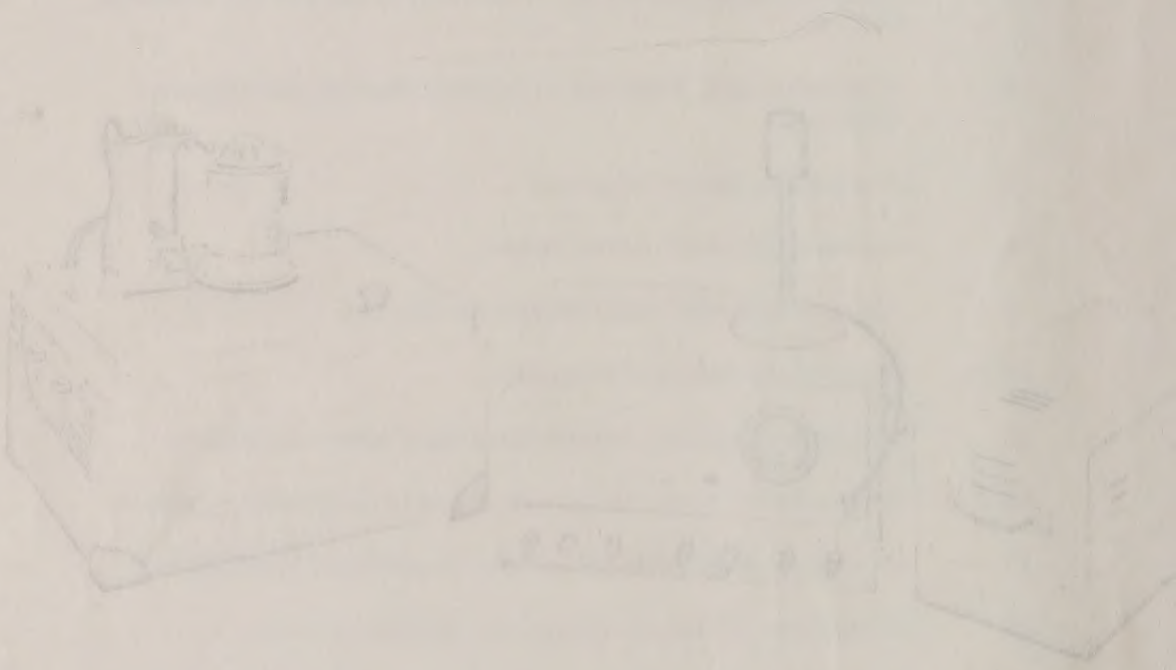


Fig. 1 SONA-GRAPH: Power Supply, Amplifier-Analyzer and Recorder



SECTION I

GENERAL DESCRIPTION

A. Introduction. -

The SONA-GRAPH is an instrument which analyzes a complex signal as a function of both frequency and time. The resultant portrayal, known as a SONAGRAM, displays frequency along the vertical axis, time along the horizontal axis, and intensity by the darkness of the pattern. This type of automatic analysis is very useful in giving a clear and permanent picture of complex signals that vary with time.

In normal operation, a SONAGRAM portrays the frequency region from 85 to 8000 cycles in a vertical distance of 4 inches and covers a period of time equivalent to 2.4 seconds for a horizontal distance of approximately 12-1/2 inches. A recorded signal can be analyzed by this method in about 5 minutes. If, under certain conditions, only portions of the frequency spectrum are of interest, they alone may be analyzed, with a corresponding saving in time.

In operation, a sample of the wave to be analyzed is first recorded on a magnetic disc. After the desired signal is recorded, it is reproduced repeatedly at a speed of 3.33 times the recording speed. On each repetition, a slightly different portion of the signal spectrum is scanned by either a 45-cycle or 300-cycle band-pass filter. The output of the analyzing filter is then recorded on dry facsimile paper that is fastened around a drum rotating in synchronism with the magnetic disc. The recording stylus shifts gradually along the frequency scale in step with the scanning oscillator. Fluctuations of intensity at the output of the filter will show up on the SONAGRAM as light or dark areas, with the higher energy levels producing the darker regions.

In some applications, the limited range of the recording paper may make it impossible to obtain a SONAGRAM with a sufficiently sensitive indication of amplitude variation. Under these conditions, a second type of analysis, known as a SECTION, may be made. This auxiliary presentation provides, at any preselected point in time, a portrayal of amplitude in the horizontal direction versus frequency in the vertical direction.

In theory, the SECTION is made by connecting the output of the analyzing filter to a Sectioner circuit. This circuit integrates the filter output energy over a 5-millisecond period at a preselected point in time. This energy is then used to control the duty cycle of a multivibrator oscillator which, in turn, provides the marking voltage for the recording paper. The portrayal is made on a uniform decibel scale with a maximum range of 35 db. This range corresponds to a horizontal distance of about 1-1/2 inches; consequently, at any one time SECTIONS cannot be made closer than 0.3 to 0.4 seconds (approximately) on the time scale of the SONAGRAM.

A third type of portrayal, providing a permanent record of the variation of average amplitude versus time, may be obtained by using the AMPLITUDE DISPLAY UNIT (figure 2) as an accessory to the SONA-GRAPH. This portrayal, using an amplitude scale that is logarithmic over a 24-db range, is produced on the top 1-1/2 inches of the SONAGRAM paper. The AMPLITUDE DISPLAY UNIT takes the reproduced signal from the magnetic disc and, after amplifying and rectifying it, converts it to a bias voltage which varies logarithmically with the input. This bias voltage is used to control the frequency output of an f-m oscillator. This varying frequency is then fed into the SONA-GRAPH analyzing filters and thus to the SONA-GRAPH marking circuits.

SECTION I

GENERAL DESCRIPTION

A. Introduction. -

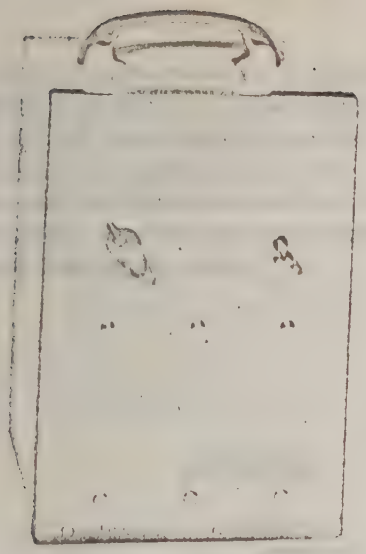


Fig. 2 Amplitude Display Unit

B. Major Units. -

The SONA-GRAPH consists of three units: the Recorder, the Amplifier-Analyzer and the Power Supply. Figure 1 shows these three units connected for operation. Where the nature of the study requires an accurate and permanent record of variation in amplitude with time, the AMPLITUDE DISPLAY UNIT (see figure 2) is available as an accessory to the SONA-GRAPH. For shipment or moving from one location to another, the individual units can be handled separately merely by disconnecting the interconnecting cables.

e weights and overall dimensions of each unit are given below:

it	Weight (lbs.)	Dimensions (inches)
corder	48	19 x 17 x 18
nplifier-Analyzer	27	14 x 17 x 9
wer Supply	35	8 x 17 x 10
nplitude Display Unit	5	7 x 10 x 7

Purpose of the SONA-GRAPH. -

The SONA-GRAPH is a useful laboratory instrument for studying the nature of frequency and time distributions of energy in any type of complex wave. One large ld of application is in speech studies, covering such areas as phonetic research, eech correction, foreign language studies, and as an aid in helping the deaf to im-ove their speech. It is particularly useful in the speech field, since speech by ture is of complex frequency composition and varies rapidly with time, making alysis by other methods very difficult. Its application to speech problems also ggests its use for similar sounds in nature. Another important application is in the dy of machinery noises and mechanical vibrations. Other possible uses of the in-ument are in the fields of music and medicine. In the medical studies, it is a uable aid in measuring electrical potentials set up by such actions as heart beats i brain waves. In the medical and musical applications, the SONA-GRAPH can be dified to provide a more usable representation of the signal. For instance, since sical tones are separated by logarithmic intervals, the substitution of a logarithmic quency scale for the linear scale used in the standard model is advantageous in the ld of music. In the medical applications mentioned, the frequencies of interest are ry low, probably going up to 30 cycles. This problem is handled by recording the nal very slowly and using a high-speed-up ratio, e. g., 200:1, which would step cycles up to 6000 cycles and thereby make the pattern utilizing 3" (75%) of the rmal frequency range. Further details about this low frequency SONA-GRAPH may obtained by writing the Kay Electric Company.

Frequencies above the range of the instrument can be made usable by modulation tems to bring these frequencies within the capabilities of the device. If the fre-ncies to be examined are not too high, it is sometimes satisfactory to record them nigh speed and then reproduce them at high speed.

Where numerous or prolonged signals must be studied, the Kay Electric Company SONALATOR is a valuable and time-saving adjunct to the SONA GRAPH. The SONALATOR provides a visible display of the instantaneous signal components on a long persistence cathode-ray tube. This continuous display enables the operator to monitor the signal in question until a point of particular interest is reached. This portion of the signal can then be permanently recorded on the SONA-GRAPH and analyzed with resultant saving in time.

SECTION II
ASSEMBLING FOR USE

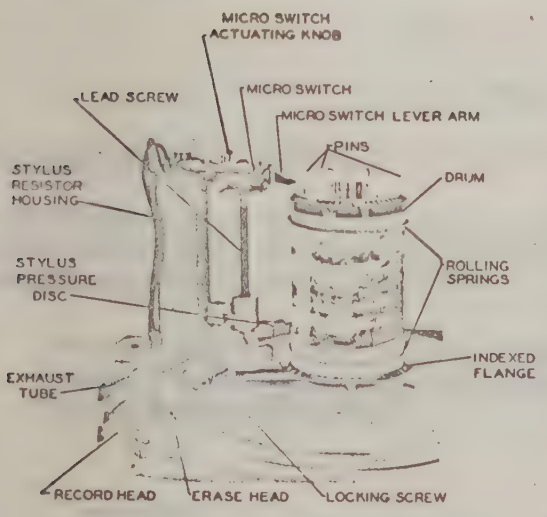


Fig. 3 Drum and Stylus Assembly

A. All units should be unpacked very carefully. Remove the inspection plate on the cover of the Recorder unit and remove all packing material from around the record and erase heads (figures 3 and 7). Contact pressures of these heads are then adjusted by means of "spring-loaded" ratchets. The best results will be obtained by turning these ratchets to a point at which both heads produce a small amount of pressure on the magnetic tape (approximately 30 grams). Hold the head(s) securely while making this adjustment to avoid hitting the heads against the turntable and damaging them. Excessive pressure will cause wear and unwanted noise. Loosen the locking screw on the turntable, and rotate drum by hand to make certain no damage has occurred during shipment. This screw is readily accessible near the stylus lead screw on the Recorder unit and is tagged.

CAUTION

To protect the equipment from damage, the locking screw should be tightened any time the unit is closed up and moved about, no matter how short the distance.

B. The Recorder unit should be kept away from strong magnetic fields to prevent the magnetic disc from becoming magnetized by stray fields. Set the Recorder unit next to the Amplifier-Analyzer unit for convenience in operation. The Power Supply should be set apart from the other units to minimize power hum pickup.

C. Connect the three units by the cable assemblies that are supplied with the SONA-GRAPH. All interconnecting cables are designed with different terminations to eliminate the possibility of making a wrong connection. If an AMPLITUDE DISPLAY UNIT is to be used, insert its input cable into the Jones connector on the left side of the Amplifier-Analyzer unit. In addition, the jumper between R-25 and the record-reproduce amplifier output (point X on amplifier-analyzer schematic, figure 17) must be removed.

D. Once the units have been connected properly, the line cord supplying power to the SONA-GRAPH should be connected. All standard units have a 115-volt, 60-cycle, operation voltage. Standard units can be adapted to special voltage or to 50-cycle requirements upon request when order is placed.

Place power switch on the Amplifier-Analyzer in the ON position. The Recorder started by means of a toggle switch located inside the access door, next to the interconnecting cables. With the Speed Shift knob in the OFF position, allow the Recorder run until the rubber drive wheels are at the proper operating temperature (20 to 30 nutes).

NOTE: When the Recorder is not in operation, the Speed Shift knob should always be in the OFF position.

Before the speed shift lever is engaged, lower the stylus assembly to bottom of d screw; then engage the drive and allow the drum to rotate.

SECTION III

OPERATION

Recording a Signal. - (see figures 3 and 4)

The Microphone Input Jack provides a 30-ohm balanced input for the Western ctric 633C Microphone supplied with the SONA-GRAPH. For recording a signal, following procedure is recommended:

1. Turn the RECord-REProduce LEVEL control on the Amplifier-Analyzer unit to zero and connect the signal to be analyzed to the MICROPHONE jack.

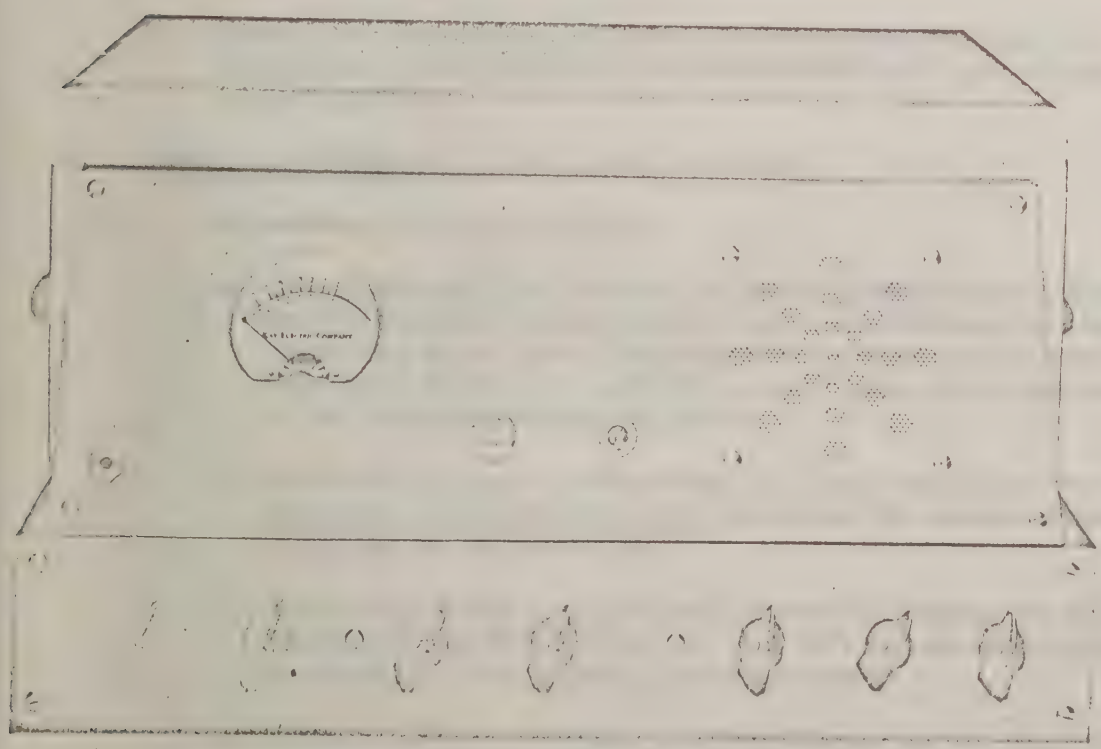


Fig. 4 . Amplifier-Analyzer Unit

2. Operate the shaping switch on the Amplifier-Analyzer unit to the desired position of FL-1, HS or FL-2. (The HS position is recommended for recording speech.)

3. Set the RECord-REProduce switch on the Amplifier-Analyzer unit to RECord.

4. Operate the speed shift on the Recorder unit to RECord.

5. With the signal fed into the MICROPHONE jack, rotate the RECord-REProduce LEVEL control to read a maximum of +3 VU on signal peaks. Keep average signal down to -5 VU.

6. After a suitable signal has been recorded, immediately turn the RECord-REProduce switch on the Amplifier-Analyzer unit to the REProduce position. The last 2.4 seconds of signal preceding the switching will remain recorded on the magnetic disc.

7. This sample is then reproduced continuously and can then be monitored by turning up the MONITOR GAIN control to a convenient listening level.

8. If the sample recorded is not satisfactory, the operator may erase the signal by turning the RECord-REProduce switch to the RECord position. Another signal can now be recorded by repeating steps 3, 4, 5 and 6.

9. When a suitable sample has been recorded, stop the drum by moving the speed shift lever on the Recorder unit to the center or OFF position.

B. Making a SONAGRAM. - (See figure 5 a and b)

1. Placement of Recording Paper.

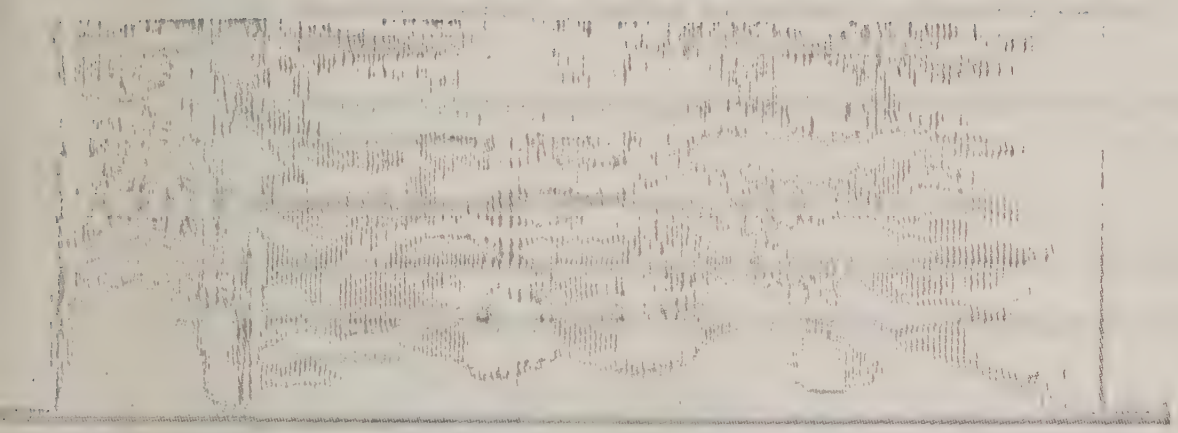
   a. Set MONITOR GAIN control and RECord-REProduce LEVEL control on the Amplifier-Analyzer unit to give a convenient listening level; rotate the drum on the Recorder unit by means of the large knurled nut on top of the drum until the switch click, which indicates the end of the recorded sample, is heard.

   b. Move the stylus on the Recorder unit over toward the drum, but do not allow it to touch the drum; determine the number directly below the stylus on the indexed drum.

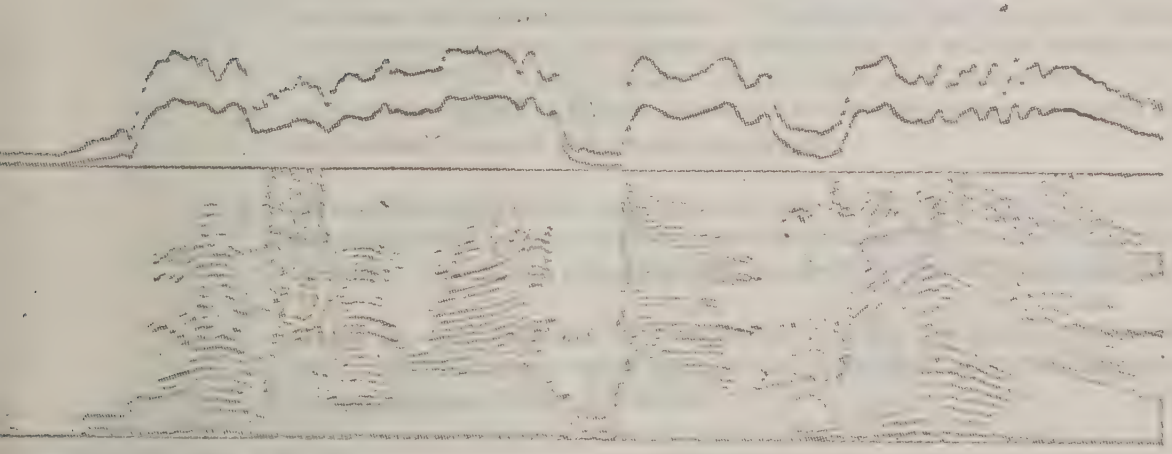
   c. Return the stylus to its position of rest by rotating the stylus holder handle counterclockwise as far as it will go and allowing the holder to drop gently to the bottom of the lead screw.

   d. Rotate the drum clockwise until the number on the drum determined in step "b" lines up with the index mounted on the Recorder cover plate. The end of the recorded sample will now coincide with this index.

   e. Wrap the recording paper in a counterclockwise fashion around the drum



a. #1 Wide



c. #1 Narrow With Amplitude Display Pattern

Fig. 5 SONA-GRAPH Patterns - Typical Sonagram (#1 Display) Patterns

with the end of the paper over the index. The paper should then be pushed down so that it rests on the bottom flange of the drum.

NOTE: Placing the paper on the drum in the wrong direction will cause the stylus to pick up and tear the paper.

f. Secure the paper, at the top and bottom, by means of the two rolling springs.

g. The end of the recorded signal and the end of the recording paper will now coincide.

2. Portrayal of Recorded Signal.

a. Be certain RECord-REProduce switch is in REProduce position.

b. Operate the SECTIONER switch on the Amplifier-Analyzer to the OFF position.

c. Operate the band selector on the Amplifier-Analyzer to NARROW or WIDE, according to resolution desired.

d. Operate the shaping switch on the Amplifier-Analyzer to the desired position of FL-1, HS or FL-2.

e. Set the speed shift knob on the Recorder to REProduce.

f. Adjust the RECord-REProduce LEVEL control on the Amplifier-Analyzer to give a reading of approximately -2 VU on the VU meter for peak deflections of speech. For signals having steep wave fronts, a reproducing level of approximately -15 VU will be more desirable. -15 VU will introduce less 2nd harmonics.

g. Adjust the MARK LEVEL control so that the voltage at the stylus is sufficient to mark the recording paper.

h. Bring the stylus into contact with the recording paper by moving the handle on the stylus holder clockwise until the holder slips into its indent. The SONA-GRAPH will then make the SONAGRAM automatically.

i. When the SONAGRAM is completed, return the stylus to its position of rest, set the speed shift knob to the OFF position, and remove the recording paper from the drum.

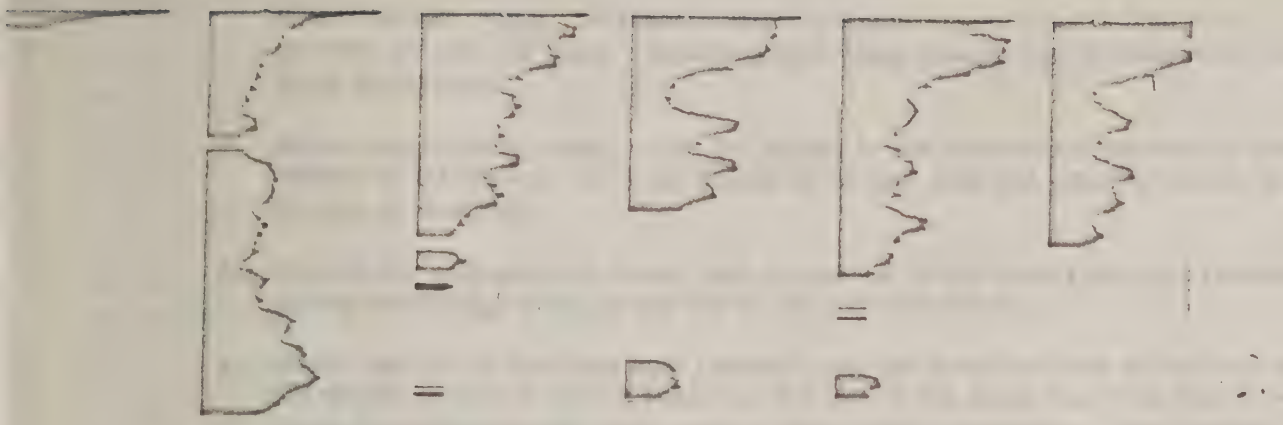
C. Taking a Section. -

A Section, as explained before, provides an amplitude versus frequency display at any preselected point in time. The top of the Recorder drum is divided into sixty units. A Section can be made at any one of these positions by following the procedure below:

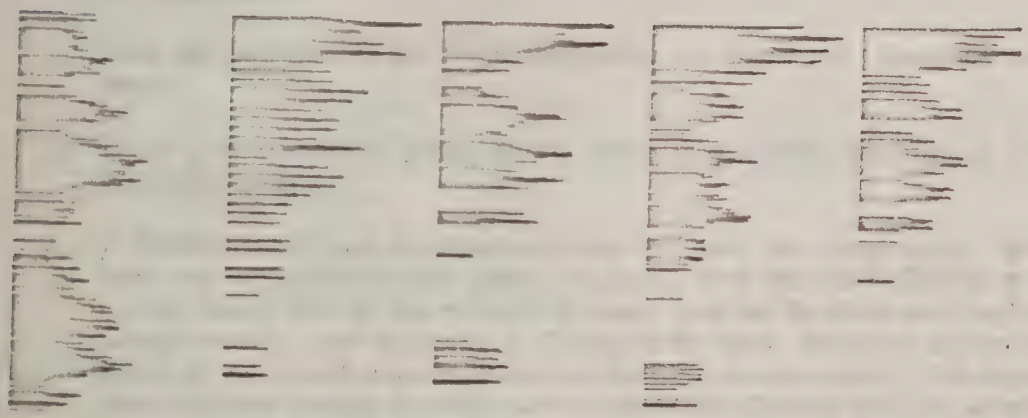
1. Determining point at which Section is taken.

a. Make a normal SONAGRAM as explained in paragraph III-B2.

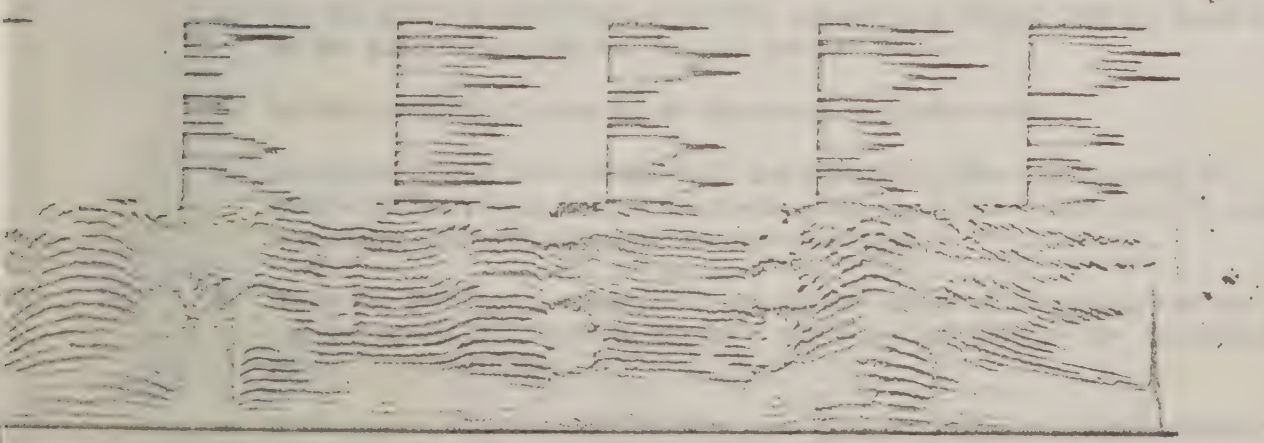
b. Determine the points at which the amplitude analysis is to be made on the



a. #2 Wide



b. #2 Narrow



c. Composite Pattern, #1 Narrow Below, #2 Narrow Above

Fig. 6 SONA-GRAPH Patterns - Typical Section (#2 Display) Patterns

SONAGRAM. Note: Sections cannot be made closer than 0.3 to 0.4 seconds at any one time. Points closer than this period in time must be made separately.

c. Rotate the drum by hand, with the stylus in the recording position at the bottom of its travel, until the stylus is in line with the point at which the Section is desired.

d. Unlock the microswitch lever arm by means of the small knurled (microswitch actuating) knob on the top of the stylus housing.

e. Insert one of the knurled pins (stored near the knurled knob on the top of the drum) in one of the 60 holes on the top of the drum that will just release the microswitch lever arm at this point of analysis. For proper operation, pins must trip sectioner microswitch lever arm.

f. For future reference, mark the SONAGRAM to indicate where the Section is being made.

g. Note the position of the recording paper on the drum. Remove completed sheet.

h. Place a new sheet of paper on the drum in the same position as the sheet just removed.

i. If SONAGRAMS and Sections are only to cover the range up to 4000 cycles, both can be placed on one sheet of paper, with the SONAGRAM recorded on the lower half of the recording paper and the Section starting immediately above. (See figure6c.) This can be done, because the frequency scale is reversed when making the Section; consequently, the Section will start at 4000 cycles directly above the SONA-GRAM and end at zero frequency at the top of the recording paper.

2. Portrayal: Section of Recorded Signal.

a. Set the RECord-REProduce LEVEL control and MARK LEVEL control on the Amplifier-Analyzer to their proper values.

b. Set the speed shift knob on the Recorder to REProduce.

c. Bring the stylus into contact with the recording paper by moving the handle on the stylus holder clockwise until the holder slips into its indent. The SONA-GRAPH will then make the Section.

d. When the Section is completed, return the stylus to its position of rest, set the speed shift knob to the OFF position, and remove the recording paper from the drum.

e. If the paper with the Section is placed directly below the SONAGRAM, the base of the Section should line up with the point on the SONAGRAM at which the Section was to be taken. Note that the Sectioner frequency scale is reversed.

Using Amplitude Display Unit. - (See figure 2 and figure 5c)

1. Set AMPLITUDE DISPLAY control to OFF position. Record a sample of the sound signal as described in paragraphs IIIA and IIIB.

2. Set RECord-REProduce switch to REProduce position.

3. Turn BAND SELECTOR switch to NARROW.

4. Adjust MARK LEVEL control until -3 VU peaks register on meter. Be certain SECTIONER switch is in OFF position.

5. Turn the AMPLITUDE DISPLAY switch to the ON position.

6. Lower the marking stylus to a point about 1-3/4 inches below the top of the paper. At the same time, depress the BASE LINE switch and allow the drum to rotate until the stylus begins to mark. Continue to hold the BASE LINE switch down until the drum has made an additional 3 or 4 revolutions and a solid base line has appeared. Then release the BASE LINE switch and allow the SONA-GRAPH to produce the amplitude display.

7. If the peaks of energy run off the top of the paper, turn the AMPLITUDE DISPLAY switch to the -10 db position. This will decrease the input to the amplitude display circuits by 10 db and reduce the height of the amplitude display pattern by approximately 3/8 inch.

SECTION IV
THEORY OF OPERATION

Functional Operation. -

The functional operation of the SONA-GRAPH can best be followed by reference to re 7 . With the RECord-REProduce switch (S-2) in the RECord position, the cir- operates as follows:

1. The signal to be analyzed is fed from jack J-1 to the input of the record-reproduce amplifier through RECord-REProduce switch S-2. The RECord-REProduce LEVEL control, together with the various shaping networks, are incorporated in this amplifier.

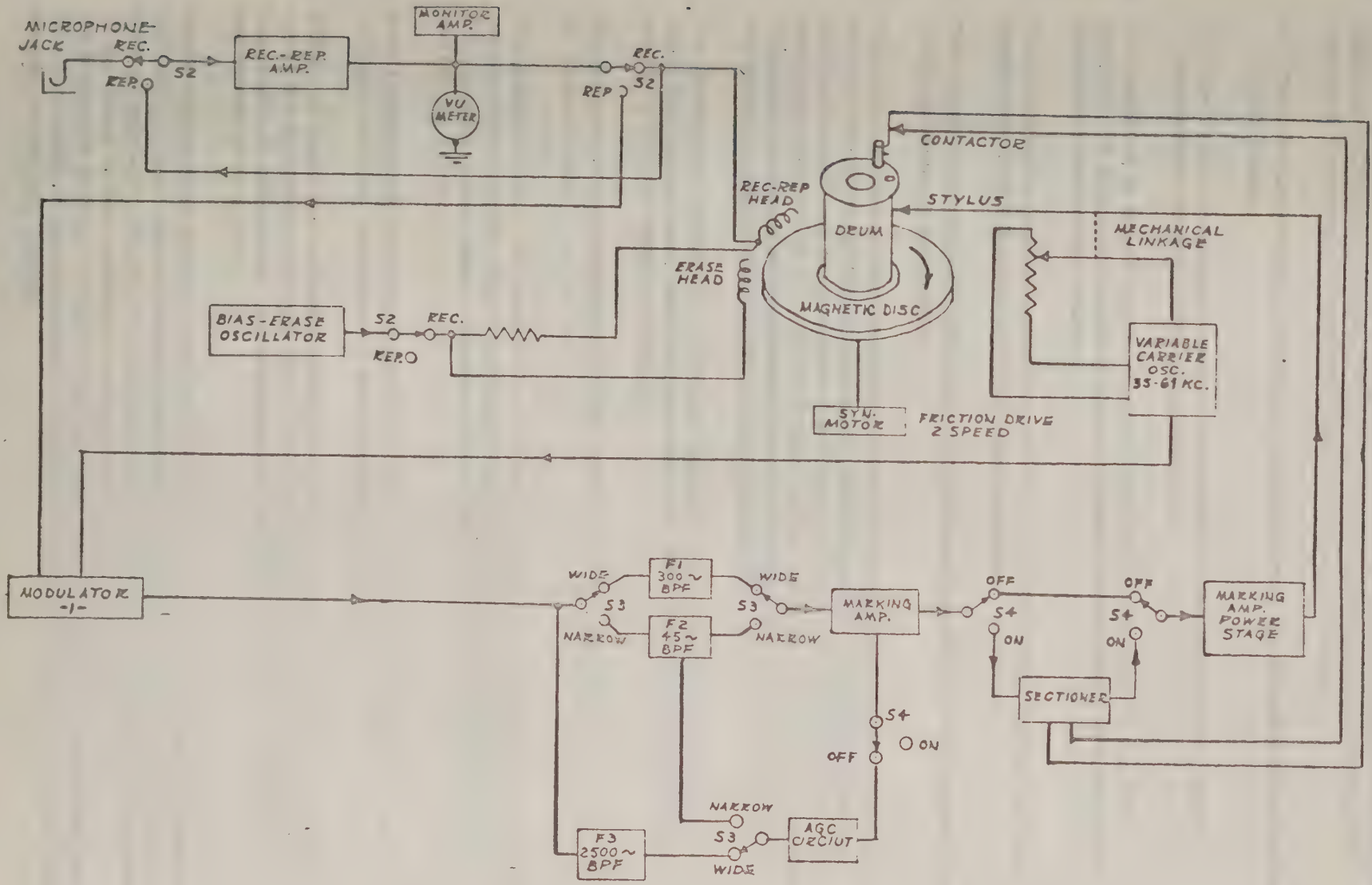
2. The output of the record-reproduce amplifier is connected to the record-reproduce head by switch S-2.

3. The VU meter and monitor amplifier are connected across the output of the record-reproduce amplifier.

4. The BIAS-ERASE oscillator supplies bias current to the record-reproduce head and erase current to the erase head.

5. The input signals go through the record-reproduce amplifier and are recorded continuously on the magnetic disc that is driven at 24 r.p.m. by a synchronous motor.

6. The recorded signals are erased 2.4 seconds later by the erase head. Consequently, the last 2.4 seconds of the input signal recorded remain on the magnetic disc.



SONA-GRAPH FUNCTIONAL BLOCK DIAGRAM

FIG.7

7. When the desired 2.4 seconds of signal is recorded on the magnetic disc, the RECord-REProduce switch, S-2, is thrown to REProduce, capturing this period of the signal. The circuit then functions as follows:

   a. The bias and erase currents are removed from the record-reproduce and erase heads.

   b. The record-reproduce head is transferred to the input of the record-reproduce amplifier through switch S-2.

8. The machine is then stopped by placing the speed shift knob in the OFF position. A sheet of recording paper is placed on the drum, and the SONAGRAM is produced as follows:

9. The recorded signal is reproduced at 80 r.p.m. by placing the synchronous motor speed shift knob in the REProduce position.

10. The signal is amplified by the record-reproduce amplifier and impressed on the first balanced modulator.

11. The stylus is moved into contact with the recording paper and then driven upward by the action of the lead screw. When the short is removed from the marking amplifier, the position of the stylus holder starts the variable carrier oscillator going at 35 kc. As the holder moves upward, the carrier oscillator frequency is increased continuously until it reaches 61.6 kc, at which time the short is again applied in the marking amplifier.

12. The modulator sidebands are passed through an intermediate frequency amplifier whose pass band is centered at 35 kc, thus selecting the lower sideband of the modulator output.

13. The output of the modulator is fed through an IF amplifier centered at about 35 kc.

14. The output of this IF amplifier is then impressed on either of two analyzing band pass filters whose midband frequencies are at approximately 35 kc. Consequently, the lower sideband of the modulator is accepted by the analyzing filter.

15. Small unbalances in the modulators permit 35 kc carrier leakage to pass through the filter to produce a zero frequency baseline.

16. Either of these two analyzing bandpass filters (narrow or wide) is selected by BAND SELECTOR switch, S-3. The wide-band filter has an effective bandwidth of 300 cycles, and the narrow-bandpass filter has an effective bandwidth of 45 cycles.

17. BAND SELECTOR switch, S-3, also determines the type of signal applied to the AGC circuit. On WIDE band analysis, the bandpass filter, with its midband at approximately 35 kc, selects a band of energy about 2500 cycles wide at the output of the modulator and applies it to the AGC circuit. On the NARROW setting, a band of energy centered at about 35 kc and having an effective width of approximately 135 cycles is tapped off filter, F-2, and then applied to the AGC circuit

18. The output of the analyzing bandpass filter is applied to the marking amplifier.

19. The output of the AGC circuit controls the gain of V-12 in the marking amplifier so as to compress a large volume range of signals within the marking range of the recording paper. The amount of this control voltage can be varied by means of an internal potentiometer, P-5.

20. When making SONAGRAMS, the AGC circuit is active and the marking signal is fed directly through to the power stage of the marking amplifier.

21. The output of the marking amplifier is connected through a step-up transformer to the stylus which then sends a current through the paper to the drum, marking the recording paper.

22. When making a Section, the Sectioner is placed in the circuit by SECTIONER ON-OFF switch, S-4. This switch also disables the AGC circuit and inverts the frequency of the variable carrier oscillator so that it starts at 61.6 kc and ends at 35 kc.

23. The point at which the Section is to be made and the time at which the Sectioner circuit operates is determined by the location of the pin on top of the drum.

24. The Sectioner then gives a spurt of energy whose duration is proportional to the energy at the output of the analyzing filter at that time.

25. The output of the Sectioner then passes through the power stage of the marking amplifier to the stylus which makes a line of fixed density but of varying "height" over a horizontal amplitude range of about 35 db.

26. When the Amplitude Display Unit is properly connected, its circuits utilize the voltage variation appearing at the record-reproduce amplifier output to produce a frequency modulated output.

27. The frequency modulated output of the Amplitude Display Unit is fed through the modulation system and the analyzing filter to the stylus where it produces an indication of amplitude vs time variation of the recorded signal.

B. Recorder Unit. - (See figure 1.)

1. Magnetic Heads.

Figure 8 shows the manner in which the magnetic heads are mounted and the manner in which they make contact with the magnetic disc. Two heads are employed, one for recording and reproducing, the second for erasing. The felt pad to the right of the erase head helps prevent particles of dirt from getting to the point where the heads must be in intimate contact with the disc at all times. Each head is held against the magnetic disc by means of a spring, at the pivot point of the arm, which maintains a pressure of approximately 30 grams at the point of contact.

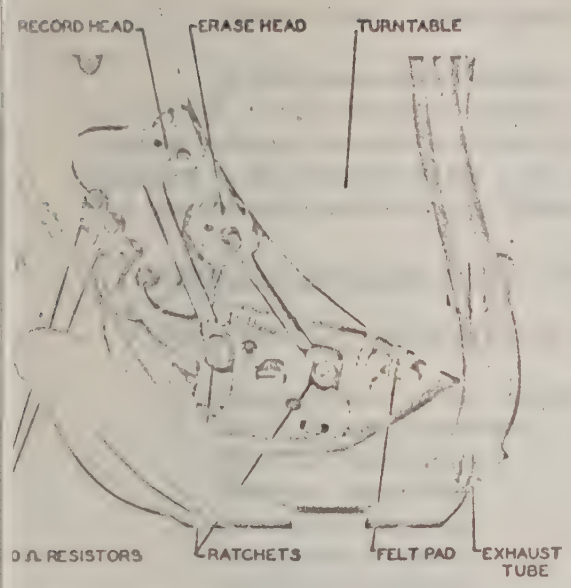


Fig. 8 Record and Reproduce Heads

During the recording, the bias current flows through the record-reproduce head and the erase current flows through the erase head. Under these conditions, a continuous process is terminated, the record and erase coil circuits are opened, and the last 2.4 seconds of signal remain recorded on the disc. This signal is then repeated once for every revolution of the disc.

2. Magnetic Disc.

The magentic disc is a 12-inch diameter turntable whose outer rim is plated a layer of magnetic material. The inside rim of the turntable is driven by a :hronous motor through a rubber drive wheel. The turntable is driven at 24 r.p.m. n recording and at 80 r.p.m. when reproducing.

3. Stylus Assembly and Drum. (See figure 3.)

The metal drum, on which the recording paper is placed, is approximately ches in diameter and 7 inches high. This drum and the magnetic disc are keyed common shaft and thus rotate in synchronism. The drum is held in position by a ge knurled nut at the top of the drum. Two rolling springs are provided on the drum old the recording paper in position.

The drum and disc shaft are mechanically coupled, via a rubber drive belt a reduction gear box, to the stylus lead screw. The rate of the lead screw is such the stylus makes 96 complete revolutions as the stylus holder is driven upward inch across the marking paper. The stylus itself is a length of 10 mil stainless el wire, spring mounted in the throat of the hard rubber fume exhaust tube. A all bakelite disc on the rear of the stylus holder permits the operator to adjust the us pressure to approximately 20 grams, the normal operating pressure.

To prevent extraneous markings from being recorded on the paper, the us assembly includes provisions for shorting out the stylus at each end of its vel. An arm of the stylus holder extends into the stylus assembly housing and nts two electrical contacts. One contact grounds the screen of V-12, the fre- ncy doubler in the marking amplifier, whenever the stylus holder is at the extreme its of the lead screw. The second contact rides on a linear adjustable resistor and trols the bias and output frequency of the variable carrier oscillator, V-6.

The microswitch lever arm, the microswitch, and the microswitch lever arm k, all a part of the Sectioner circuit, are located on top of the stylus housing. An usting screw, located on top of the microswitch plate, regulates the position of the croswitch lever arm and thus the operation of the microswitch circuit.

4. Blower Unit. (See figure 10.)

In the process of making a SONAGRAM, a considerable amount of smoke is generated. This smoke is drawn off via the hard rubber tube on the stylus holder, a flexible rubber tube and a filter by a blower motor. The blower and filter units are fastened to the bottom of the case housing the Recorder Unit. It should be mentioned that the blower operates only when the speed shift knob is in the REProduce position.

C. Amplifier-Analyzer Unit. - (See figure 4.)

The Amplifier-Analyzer unit comprises the following assemblies:

Record-Reproduce Amplifier
Bias-Erase Oscillator
Carrier Oscillator
Monitor Amplifier
Modulation System
Analyzing Filters
Marking Amplifier
Automatic Gain Control Circuit
Sectioner Circuit

Figure 16 shows a complete schematic of the Amplifier-Analyzer unit and will be helpful in following the detailed descriptions given below:

1. Record-Reproduce Amplifier.

The Record-Reproduce Amplifier consists of three vacuum tubes, V-1 through V-3, and their associated components. During the recording process, the signal which is to be recorded is applied to the grid of V-1 by placing the RECord-REProduce switch, S-2, in the RECord position. The signal then passes through the amplifier to the record-reproduce head. To accommodate signals of varying frequency composition, the characteristic of this amplifier can be altered by means of the shaping switch, S-1. With S-1 on position 1 (FL-1), the amplifier has an essentially flat, constant current, recording characteristic. On positions 2 and 3 (HS and FL-2), the characteristic of the recording amplifier is altered so that its response increases with frequency. This high frequency shaping amounts to about 15 db over the entire range and is used mainly when speech is being recorded. This means of recording is used in order to show up frequencies above the 1000 cycle region where the energy of the voiced speech sounds starts to decrease. Figure 11b shows the characteristic of the recording amplifier for the three shaping positions: FL-1, HS and FL-2. The output of the amplifier circuit is monitored by a DB-meter whose scale is calibrated in VU's (volume units). The amplifier output circuitry includes a frequency trap tuned to the bias frequency to prevent this component from causing a false indication on the VU meter.

On REProduce, the amplifier response design must take into account the characteristic of the recording medium, the equalization introduced during the recording process and the increased frequency range that must be handled due to the 3.33 speed-up on REProduce. Similarly, inflection points, cutoff networks, and the bandwidths of filters and amplifiers must also be raised by the factor of 3.33. Thus, for a top frequency of 8000 cycles (recorded), the reproduce system must be capable of handling frequencies up to 26,640 cycles (8000 x 3.33). Switches S-1 and S-2 correct for all these factors in the REProduce condition.

4. Blower Unit. (See figure 10.)

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The output of the reproduce amplifier is taken off at the plate of V-3b. This nal then passes through a resistance pad to the modulator. The characteristics of complete reproduce amplifier for the three conditions of shaping are shown on re

The overall frequency responses of the record amplifier, magnetic medium, ord-reproduce head and reproduce amplifier for the three conditions of shaping are vn on figure 12. These three curves show the essentially flat frequency character- s that are obtained on the FL-1 and FL-2 conditions and the rising characteristic is obtained on the HS setting.

2. Monitor Amplifier.

To enable the operator to listen to the signal being recorded or reproduced, a itoring amplifier, V-4, and loudspeaker are bridged across the output of the record- oduce amplifier. Potentiometer, P-2, the MONITOR GAIN control, may be used ary the output level of the monitor stage.

3. Bias and Erase Oscillator.

The bias-erase oscillator consists of a multi-vibrator circuit , figure 16) in the Amplifier-Analyzer unit and is activated only when SONA-GRAPH is in the recording position. The 75KC output of the oscillator sed to supply a current of about 17 milliamperes to the erase head to re- from the magnetic disc all previously recorded signals, clicks and sients introduced by the switching process. This high frequency also es to supply a bias current of about 2 milliamperes to the record- oduce head during the recording process.

4. Modulation System.

Although the upper limit of the magnetic disc recording range is a nominal cps, under reproduce conditions each recorded frequency will be multiplied by a or of 3.33 due to the speed-up of the magnetic disc during playback. Consequently, als up to approximately 26.6 will have to pass through the modulation system to 35 kc analyzing filters. This range of signals is accommodated by using a metallic nced modulator in demodulation and selecting the lower sideband from it. The lation system comprises a variable carrier oscillator, a copper oxide balanced ator, and provisions for mixing.

5. Carrier Oscillator.

The variable carrier oscillator consists of a multivibrator, V-6, followed by gle stage of amplification. V-7, which supplies a carrier with a nominal 1-volt t to balanced modulator, (MOD). The variable carrier frequency varies over nge of 35 kc to 61.6 kc, according to the level of d-c bias supplied by the 10K ble resistor in the stylus housing. The bias level is, in turn, determined by the rd movement of an electrical contact secured to the interior end of the stylus r.

The variable carrier output is mixed with the output of the record-reproduce fier (0 to 26.6 kc) to produce a difference frequency of 35 kc as it leaves the This IF is passed through a single stage of amplification, V-10 and then fed to nalyzing filters.

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6. Analyzing Filters.

Two analyzing filters are available in the SONA-GRAPH, the narrow-band filter, with a bandwidth of about 150 cycles, and a wide-band filter with a passband of about 1000 cycles. It should be borne in mind that since the recorded frequencies are multiplied by a factor of 3.33 for analyzing purposes, the effective bandwidths of the analyzing filters are 45 cycles for the narrow-band filter and 300 cycles for the wide-band filter. Therefore, to obtain the effective bandwidths of the analyzing filters, their pass-band must be divided by the speed-up factor of 3.33. The lower sideband of the modulator is passed through a stage of amplification, V-10, and then applied to either of the analyzing filters through BAND SELECTOR switch, S-3. Figure 9 shows the passband of the two analyzing filters.

7. Marking Amplifier.

The marking amplifier is designed to deliver approximately 150 to 200 volts of 35 kc output to a 20,000 ohm load, the average resistance of the facsimile paper while it is marking. This amplifier consists of three stages of gain (V-11, V-12 and V-16). See figure 16. The first stage of the marking amplifier takes the output of the analyzing filter and couples it to V-12, whose gain is controlled by the automatic gain control circuit. The output of the V-12 is then coupled to the power stage, V-16, through a tuned coupling circuit. This tuned coupling helps prevent frequency components other than those passed by the analyzing filter from appearing at the output of the marking amplifier. The output of the power stage is then applied to the stylus through a transformer having a voltage step-up of 1:2. The gain of this amplifier, which determines the marking on the recording paper is controlled by the MARK LEVEL potentiometer at the input of V-12 in the marking stage.

8. Automatic Gain Control Circuits.

Since the marking range of the recording paper is limited to about 6 db, means must be provided in the marking amplifier to compress the range of amplitude variations that are present in the complex signal to within this 6-db range. For example, in speech analysis, components which cover a range of amplitudes of about 40 db are of interest.

To accommodate this range of amplitudes, two separate control circuits are provided as shown in figure 16. A narrow-band control circuit is used with the narrow analyzing filter, and a second and wider control circuit is used with the wide analyzing filter. The narrow-band control circuit input is taken off the first section of the analyzing filter. This provides a control path bandwidth approximately three times as wide as the signal path, and overlaps the passband of the narrow analyzing filter. The signal from the narrow-band control circuit is then applied to an amplifier detector circuit composed of V-17, V-18 and V-19. This circuit produces a substantially logarithmic output over a considerable range over which the gain is controlled.

The wide-band control circuit is essentially the same as the narrow-band control circuit with the exception that the input to the amplifier detector circuit is obtained from a 9000 cycle bandpass filter (effective bandwidth of about 2700 cycles) that picks up the signal at the output of the modulating system.

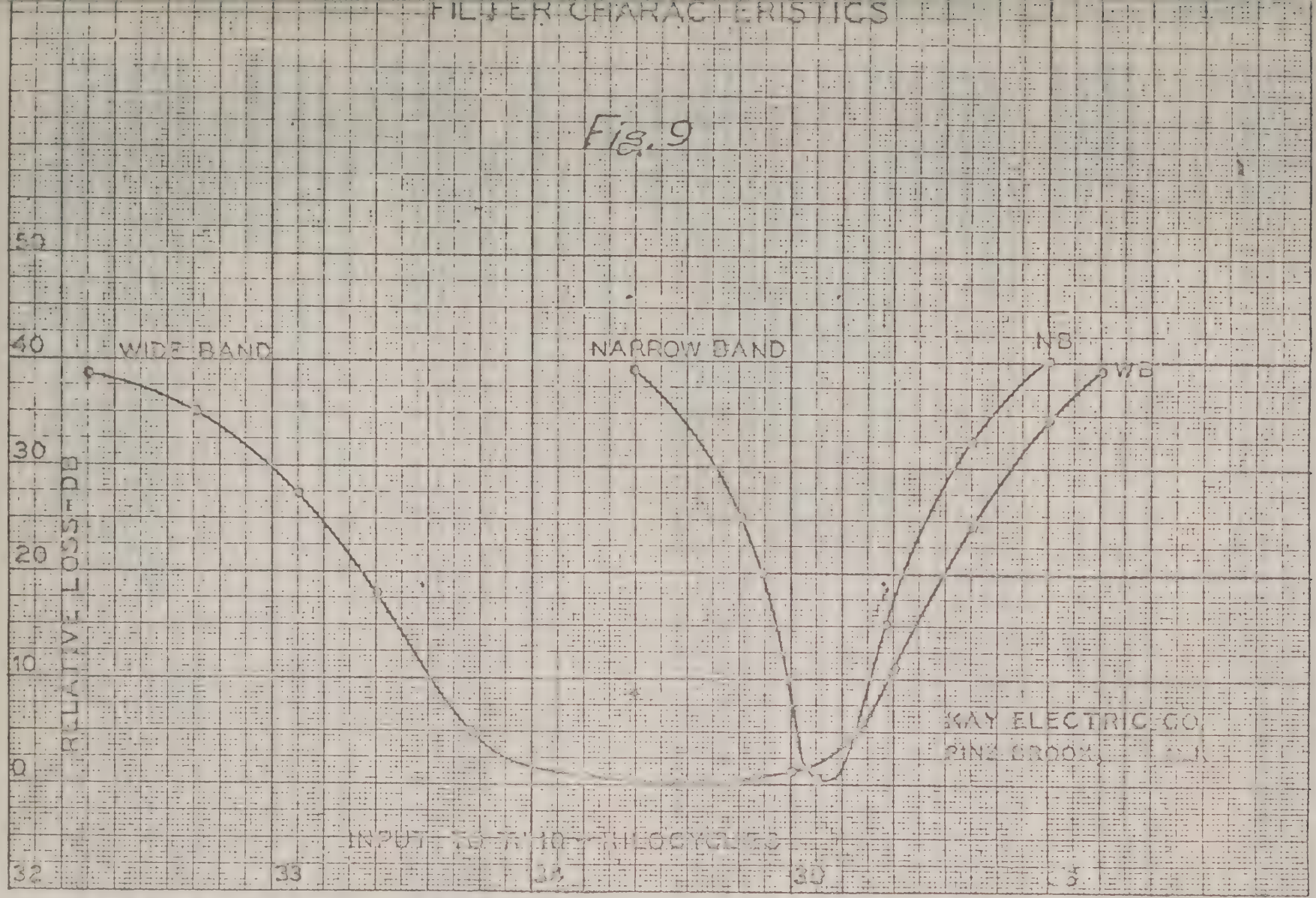

FILTER CHARACTERISTICS
WIDE BAND
NARROW BAND
NB
WB
RELATIVE LOSS DB
40
30
20
10
0
32
33
34
35
KAY ELECTRIC CO

Fig. 9

The filtered output of the detector is applied through the AGC potentiometer, P-5, as grid bias for V-12 in the marking amplifier. Under the action of this control circuit, a signal range of about 40 db at the input to the marking amplifier is compressed to about 6 db at the output when using the full bias.

9. Sectioner Circuit.

As mentioned previously, the Sectioner circuit portrays the frequency vs amplitude variation of a recorded signal over a 35-db amplitude range. This circuit, shown on the schematic in figure 16, consists of a linear diode detector, a CR integrating circuit, a d-c amplifier, V-13, an on-off trigger circuit, V-14, and a multivibrator oscillator, V-15.

The Sectioner circuit is connected between the marking amplifier (V-12) and the power stage (V-16) of the marking amplifier when SECTIONER switch (S-4) is in the ON position. It is set in operation when the Sectioner microswitch on top of the stylus housing is operated by one of the pins on the top of the recorder drum. Energizing the Sectioner circuit disables the AGC circuit and reverses the direction of frequency change in the variable carrier oscillator, V-6. Potentiometer, P-10, is normally set to bias, V-15, the succeeding multivibrator at cut-off. When the Sectioner microswitch operates, the trigger tube (V-14) supplies an enabling bias to the multivibrator oscillator (V-15). This oscillator then supplies a constant amplitude marking signal of 35 kc to the stylus through the power amplifier stage (V-16) in the marking amplifier. This produces on the paper a constant density pattern in which the length of the mark is determined by the duty cycle of multivibrator (V-15) and the length of time that the multivibrator operates is in turn determined by the value of the voltage on the condenser in the integrating circuit. The circuit is so adjusted that each 5 db of amplitude change is represented by a "height" of 5 millimeters on the recording paper.

D. Amplitude Display Unit. - (See figure 14.)

The AMPLITUDE DISPLAY UNIT consists of an amplifier-rectifier, a non-linear network, and a frequency-modulated oscillator.

The recorded signal is fed from the magnetic disc to a triode amplifier (V-401A). The amplified output of V-401A is fed to rectifier (V-401B). This stage is diode-connected to produce a linear rectifier whose d-c output will be dependent only on the a-c input at the amplifier grid and the time constants of the diode cathode circuit.

The d-c voltage at the cathode is applied to a non-linear network comprising crystal diodes D-401, D-402, and D-403, and resistors R-407 through R-415. The components of this network are chosen to produce an output which will be logarithmic over a 24-db range. This signal is applied to the grids of the frequency-modulated oscillator, V-402.

Oscillator, V-402, produces an output whose frequency is a linear function of the instantaneous voltage appearing on its grid. This instantaneous voltage, in effect, will vary as the d-c voltage coming from the non-linear net and thus logarithmically as the a-c signal appearing on the grid of V-401A. Consquently, a signal whose frequency varies logarithmically as the amplitude of a small a-c input is applied to the modulating and analyzing circuits in the SONA-GRAPH and used to produce a variation indication on the recording paper.

Power Supply Unit. -

The power supply is well regulated and has low ripple and low impedance. ure 17 shows the schematic of the complete power supply.

SECTION V

PREVENTIVE MAINTENANCE

Recorder Unit. -

1. Drum.

To obtain satisfactory SONAGRAMS, the drum should be kept clean at all s. A dirty drum will produce SONAGRAMS that are fuzzy and difficult to read. drum should be cleaned with silver polish, applied with a damp cloth. After polish been applied to the entire drum, clean off the polish with a soft, dry cloth.

To prevent motion between the drum and its driving shaft, make certain the e knurled nut on top of the drum is tight and the drum is firmly locked to its shaft.

2. Stylus Assembly.

. Do not allow the stylus holder lead screw to run dry. At regular intervals, a light coat of instrument oil to the lead screw and wipe off the excess lubricant a clean cloth.

NOTE

The lead screw bearings are adjusted, lubricated and sealed at the factory. They will not normally require lubrication or adjustment in the field.

The lead screw is belt-driven from the drum drive shaft. In case of failure, a new rubber belt can be obtained from the Kay Electric Co. Note the relationship of the stylus housing and the drum for future reference. To replace the belt, loosen the knurled nut on top of the drum and remove the drum from its drive shaft. Remove the two-piece top cover from the recorder unit. Loosen the whole styles assembly by removing the two screws that hold the assembly base to the recorder unit.

CAUTION

Do not break any of the wires connecting the stylus assembly to the recorder unit.

Place the new belt over the drum drive shaft pulley. Remove the stylus assembly gently. Move the assembly toward the magnetic disc until the free end of the rubber belt can be slipped over the lead screw pulley at the bottom of the housing. Replace the stylus assembly and secure in place. Reassemble the rest of the unit, making certain the drum and stylus have their original relationship.

3. Magnetic Disc and Magnetic Heads.

To remove accumulated dirt, the felt wiper next to the erase head should be cleaned with carbon tetrachloride every few months. After cleaning, apply a few drops of light general purpose oil to the pad before replacing it.

The magnetic discs and heads require no special preventive maintenance.

4. Blower and Filter.

The blower motor in the bottom of the recorder unit should be lubricated every six months with light general purpose oil.

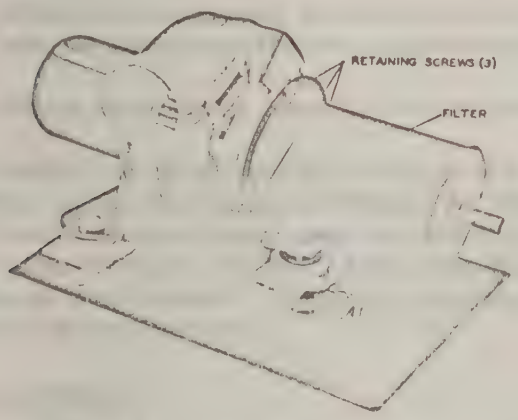


Fig. 10 Blower and Filter Assembly

If the recording process fumes are not drawn off through the exhaust tube when the blower is operating, the filter may be presumed to be clogged and should be replaced. Remove the two-piece top cover; remove the eight screws which secure the main casting to the recorder cabinet. Lift the one side of the casting and disconnect the rubber exhaust tube and the blower power connection. The filter can now be replaced by removing the screws on the lower flange of the can. (See figure 10 .) Replacement units can be obtained from the Kay Electric Company.

5. Turntable Motor and Bearing.

If the SONA-GRAPH is in regular use, the turntable motor should be lubricated every six months with a light general purpose oil. The motor oil cups may be reached by loosening and lifting the top plate of the recorder unit to which the motor is attached.

At the same time, make certain the turntable rotates freely in its bearing when the speed shift knob is in the OFF position. If the shaft binds in the bearing, move the stylus housing and heads to clear the magnetic disc. Then remove the turntable by lifting it straight up.

CAUTION

Remove and replace turntable carefully to prevent nicking either bearing or shaft surface. Slight irregularities in either surface may cause the shaft to bind. To prevent damage to the heads when removing or replacing this component, turn the head ratchets counterclockwise until both heads are clear of the turntable.

Clean the shaft and bearings and apply a few drops of general purpose oil to the bearing surfaces.

B. Amplifier-Analyzer and Power Supply. -

These units require no special preventive maintenance.

SECTION VI

CORRECTIVE MAINTENANCE & TEST SPECIFICATIONS

General. -

If the operation of the SONA-GRAPH appears to be defective in any respect, the following preliminary checks:

1. Check the operation of all SONA-GRAPH and accessory unit circuits to determine the exact nature and extent of the defect.

2. Make a visual check to determine that all filaments are lit and that there are no loose connections or obviously damaged components.

3. Check the voltage level at the a-c line, the B+ and B- input.

The most common troubles encountered with the SONA-GRAPH are weak or tive tubes, occasional misalignments, or small mechanical failures due to wear. rouble-location chart below may be used as a guide to isolate the defect to a cular circuit or stage. Table 1 indicates the normal operating voltages at sig- nt points in the circuitry. Table 2 indicates the voltage gain in each major stage Analyzer-Amplifier unit.

Trouble-Location. -

In utilizing the trouble-shooting chart below, note that the Servicing Pro- e steps should be performed in the order listed. Note also that all a-c readings oltages should be made with a Ballantine Model 643 or equivalent.

SYMPTOM	SERVICING PROCEDURE
r, fuzzy burning on SONA-PH picture.	Make certain drum is clean. Then increase stylus pressure to 20 grams.
GRAM picture has sharp ontal lines. Paper surface ny.	Decrease stylus pressure to 20 grams.
om horizontal streaks appear.	Using horizontal stroke, clean traveling contact and exposed surface of stylus housing resistor with carbon tetrachloride. Apply very thin coat of petrolatum to surface of resistor. Make certain contact is good between resistor and sliding contact.
arking on paper.	Check operating procedure.
Voltage at TJ-6 less than 250 volts d-c.	Check power supply; adjust as in paragraph VI-C1a.
Voltage at TJ-2 normal approx. 15 volts a-c).	Check lead to stylus for open circuit.

SYMPTOM Cont'd.	SERVICING PROCEDURE Cont'd.
3. Reads significantly less than +3 db with S-2 on RECord and signal into microphone.	Check record amplifier.
a. ~~With signal into microphone, Ballantine indicates voltage at TJ-10.~~	~~Check V-3B circuit.~~
b. ~~VTVM~~ at TJ-10 reads zero. BALLENTINE	Check V-1, V-2, V-3A circuits See paragraphs VI-~~C7~~ C3 and VI-C8
4. VU meter reads zero while reproducing tape signal (S-2 on REProduce) with REC-REP LEVEL control normal.	Check reproduce amplifier. See paragraphs VI-~~C5~~ C6 and VI-~~C6~~ C7
5. With S-2 on RECord, check voltage across 100-ohm resistor in series with record-reproduce head.	
a. Is outside 190-210 mv range.	Check Bias-Erase oscillator. See paragraph VI-C2.
b. Reads between 190-210 mv range.	Clean record-reproduce head with carbon tetrachloride with clean, lint free cloth. Then check record-reproduce head. See paragraphs VI-~~C9~~ C5 and VI-~~C11~~ C9.
6. Voltage at TJ-9 reads significantly less than 1 volt.	Check input to V-7. If low, check oscillator V-6. See paragraph VI-C16.
7. Voltage at TJ-2 reads significantly less than 15 volts. with 0.35V, 35 kc input at TJ-5, P-3 set to max., and stylus not shorted.	Check marking amplifier (V-12 and V-16). See paragraphs VI-~~C13~~ C12.
8. No d-c voltage (-1 to -13 volts d-c) at TJ-4 when recorded signal is replayed (S-2 on REProduce).	Check C-64 and rest of AGC circuit. See paragraph VI-~~C18~~ C17.
Reproduced signal garbled on monitor. SONAGRAM confused and complicated.	
1. Current through 100-ohm erase head resistor significantly less than 17 ma at 75 kc.	Check Bias-Erase oscillator. See paragraph VI-C2b.
2. Current through 100-ohm erase head resistor satisfactory.	Clean erase head. If this does not rectify trouble maximize contact and/or replace head.
Section marking incomplete or absent.	Check Sectioner circuit (V-13, V-14, & V-15). See paragraph VI-C19.

Test Specifications. -

The following material contains a complete procedure for testing and correcting performance of any circuit in the SONA-GRAPH and its accessories.

Voltage Checks (J-4 in Amplifier-Analyzer).

a. Set B+ (TJ-6) to +250 volts with power supply potentiometer (P-301).

b. B- (TJ-3) is -115 volts (± 5 volts), hum 3 mv maximum.

c. Filament (pins ~~7/8~~ 9/10 and ~~9/10~~ 10/11 power plug, white wire) is 6 volts (±0.3 volts).

d. B+ hum (TJ-6) measured with Ballantine, Model 643, should be less than 3 mv.

e. B+ (red wire) on V-10 should be ON when RECord-REProduce switch is in REProduce position, and OFF in RECord position.

f. Typical Troubles:

1) Excessive B+ hum - ground loop caused by grounding filament in both Power Supply and Amplifier-Analyzer; eliminated by removing ground in Power Supply.

2) VU Meter kicks up violently when changing from RECord to REProduce. Jumper from .05 μf capacitor to P-2 lead (V-3, '6SN7' socket coax #11) missing. This jumper should be removed only when the Amplitude Display Unit is used with the Analyzer.

Bias and Erase Oscillator (V-5, 6BL7).

a. Bias.

1) RECord-REProduce switch in RECord position.

2) Connect Ballantine across 100-ohm resistor in series with the record head (*figure 8*, upper head).

3) Adjust variable capacitor C-37 to maximize voltage on Ballantine. At 75 kc reading should be approximately 190-210 mv.

4) Wave shape on oscilloscope (connected across record head resistor) is 75 kc.

5) If varying C-37 does not increase bias voltage sufficiently shunt C-37 with a minimum of 15 μμf.

b. Erase.

1) RECord REProduce switch in RECord position.

2) Connect Ballantine and oscilloscope across 100-ohm resistor in series with the erase head (*figure 8*, lower head).

3) Read 2.0 volts (±0.3 volts) at 75 kc with clean sine wave on oscilloscope.

3. Record-Amplifier Gain (V-1, 5879; V-2, 6J5; and V-3, 6SN7).

   a. RECord-REProduce switch in RECord position and shaping switch on FL-1.

   b. Remove V-5 (6BL7) and V-7 (6J5).

   c. Feed between 1 & 2 mv at 1000 cps from a 22-ohm unbalanced source into the MICROPHONE jack. Ground ring to sleeve and feed signal through tip.

   d. Adjust RECord-REProduce LEVEL to give zero VU. Setting should be "20" on the panel scale.

   e. Voltage across 100-ohm resistor in series with RECord-REProduce head (R-202) should be 11 - 13 mv.

   f. Set VU meter to -5 VU with RECord-REProduce LEVEL pot, P-1.

   g. Changing shaping switch to FL-2 at HS position should increase reading to -3VU ±0.5.

   h. Vary RECord-REProduce LEVEL control, watching VU meter and Ballantine to check for any instability on any of the three shaping positions (with or without signal).

4. Demagnetize Tape.

   a. SONA-GRAPH power switch OFF.

   b. Drive turntable with external low speed means (about 3 rpm).

   c. Demagnetize turntable by holding 60-cps source against tape (do not mar tape) for several revolutions.

   d. Remove 60-cps source slowly, with turntable rotating, so no magnetic holes are produced.

5. Record Head Alignment.

   a. RECord-REProduce switch in RECord position. Shaping switch in FL-1 position.

   b. Remove V-5 (6BL7).

   c. Into mike jack with a 22 ohm unbalanced source, feed a 2.5 kc signal great enough to give 11-13 mv at "0VU" (measured with Ballantine with short leads) across the 100 ohm resistor (R-202) in series with the record head.

   d. With oscilloscope across 100-ohm series resistor, check for clean sine wave.

   e. Replace V-5 (6BL7). Check bias voltage as indicated in step 2.

   f. Remove meter leads and record at low speed.

   g. Reproduce at high speed and connect Ballantine across record head & 100-ohm resistor (R-202) to ground.

). Adjust head with set screws and read at least +25 db above 1 mv (.018 volt) on Ballantine. A low reading may be due to presence of dirt on turntable.

NOTE

When head is properly aligned, gap is at center of contact surface, turntable and head mate evenly in all three dimensions, and contact area is maximized.

Reproduce-Amplifier Gain (V-1, 5879; V-2, 6J5; V-3, 6SN7).

. RECord-REProduce switch in REProduce position.

. Remove V-5 (6BL7), V-6 (6SN7) and V-7 (6J5).

. Feed 2 mv at 1000-cps into the 100-ohm resistor (R-202) in series with the RECord-REProduce head.

. Shaping switch in FL-1 position.

. With RECord-REProduce LEVEL at maximum, VU meter will read as follows:

Shaping Switch Position	VU Meter Reading
FL-1	0±1
HS	0±1
FL-2	-2±1

Reproduce Amplifier Hum and Noise (V-1, 5879; V-2, 6J5; V-3, 6SN7).

a. RECord-REProduce switch in REProduce position. No signal input.

b. Remove tubes V-5 (6BL7) and V-7 (6J5).

c. Set RECord-REProduce LEVEL at max. (completely clockwise) and connect Ballantine to TJ-10 (short leads).

d. Hum and noise level should not exceed 24.5 db above 1 mv (0.017 volt) on any position of shaping switch.

e. As RECord-REProduce pot is rotated counterclockwise, hum should decrease.

f. If noise exceeds 24.5 db above 1 mv, change tubes V-1 (5879), V-2 (6J5), V-3 (6SN7). Short V-2 grid to ground. If hum decreases, check V-1. Then set P-1 completely counterclockwise. Decreased hum indicates bad V-2. Continued hum indicates bad V-3.

Record-Amplifier Frequency Response (V-1, 5879; V-2, 6J5; V-3, 6SN7). See *figure 11b*.

a. Remove V-5 (6BL7), V-6 (6SN7) and V-7 (6J5).

b. Feed 2 mv at 1000-cps from a 22-ohm source into MICROPHONE jack. This is a reference frequency.

c. Set shaping control in FL-1 position. Set RECord-REProduce LEVEL control (P-1) for zero VU.

d. With Ballantine, check gain in db across 100-ohm resistor in series with record head at frequencies shown below.

e. Recheck level input each time.

f. Set shaping control to HS (FL-2 will be the same as HS). Adjust RECord-REProduce LEVEL control to produce zero VU with 1000 cps input.

g. Repeat step "d".

h. In making HS checks, be sure to set VU meter for zero VU at 1000 cycles and DO NOT CHANGE SETTINGS. Recheck 2-mv input each time.

FREQUENCY CPS	OUTPUT IN DB* FL-1	OUTPUT IN DB* HS & FL-2
100	23	21.5
200	22	21.0
500	21	21.0
1000 Ref.	21	21.0
2000	21	27.1
4000	21	33.5
6000	21.5	36
8000	21.5	37**

* ±1.5 db.
** With RECord-REProduce LEVEL control at max., gain is 39 ±2 db.

9. Record Head.

a. Remove V-5 (6BL7), V-6 (6SN7) and V-7 (6J5).

b. Set up 11-13 mv drop across the 100-ohm record head resistor (R-202) by feeding frequencies below into MICROPHONE jack.

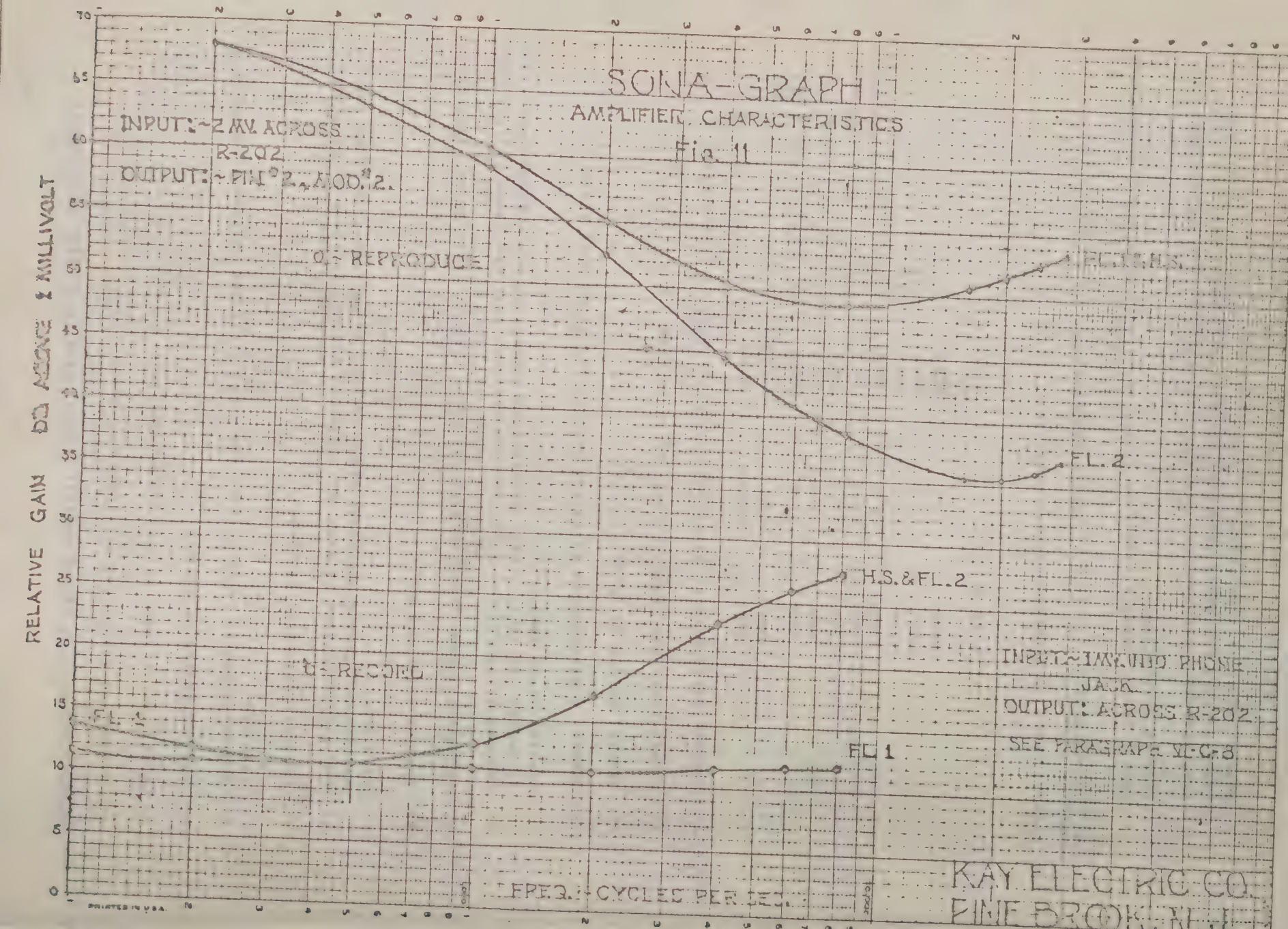
c. Replace V-5 (6BL7). Voltage across R-202 should now read bias voltage (190-210 mv regardless of frequencies).

d. Remove Ballantine leads and record at low speed.

e. Reproduce at high speed, connecting Ballantine (short leads) across record-reproduce head for output readings.

FREQUENCY CPS	OUTPUT IN DB* FL-1	OUTPUT IN DB* HS & FL-2
100	13.7	13.7
200	18	18
500	22.8	22.8
1000 Ref.	25.8	25.8
2000	27	27
4000	24.8	24.8
6000	21.4	21.4
8000	17.2	17.2

* ±.5 db.


SONA-GRAPH
AMPLIFIER CHARACTERISTICS
Fig. 11
INPUT:~2 MV. ACROSS R-202
OUTPUT:~PIN°2, MOD.°2.
O = REPRODUCE
FL. & H.S.
FL. 2
H.S. & FL. 2
O = RECORD
FL. 1
INPUT:~1MV. INTO PHONE JACK
OUTPUT: ACROSS R-202
SEE PARAGRAPH VI-C-8
RELATIVE GAIN DB ABOVE 1 MILLIVOLT
FREQ.:~CYCLES PER SEC.
KAY ELECTRIC CO.
PINE BROOK, N.J.

10. Overall Response of Record Amplifier (V-1, 5879; V-2, 6J5; V-3, 6SN7).

a. Remove V-5 (6BL7) and V-6 (6SN7).

b. Feed 2 mv at 1000 cps into MICROPHONE jack.

c. Shaping switch on FL-1.

d. RECord-REProduce LEVEL control and input (P-1) set to give zero VU at 1000 cps.

e. Connect Ballantine to TJ-10.

f. Run frequency (100 to 8000 cps input) vs output (db above 1 mv) curve, maintaining RECord-REProduce LEVEL control as in step d (zero VU for 1000 cps).

g. Shaping switch on HS.

h. RECord-REProduce LEVEL control set as in step d. (zero VU for 1000 cps).

i. Connect Ballantine to TJ-10 and run plot of frequency (~~1000~~ 100 to 8000 cps) vs output (db above 1 mv), maintaining RECord-REProduce LEVEL control setting as in step h.

j. Connect Ballantine to TJ-10 and run curve (100 to 8000 cps).

k. Shaping switch on FL-2.

l. RECord-REProduce LEVEL control set as in step d & h.

m. Connect Ballantine to TJ-10 and run curve (~~1000~~ 100 to 8000 cps).

FREQ. CPS		OUTPUT * FL-1	OUTPUT * FL-2 & HS
100		56.4	56.4
200		55.5	55.5
500		54.5	54.5
1000	Ref.	54.2	54.2
2000		54.2	60.2
4000		53.5	66.2
6000		53.5	69.2
8000		52.7	72.2

± 1.5 VB

SEE PG 16

* ±2 db

11. Overall Check on RECord-REProduce Amplifier.

a. RECord-REProduce switch in RECord position.

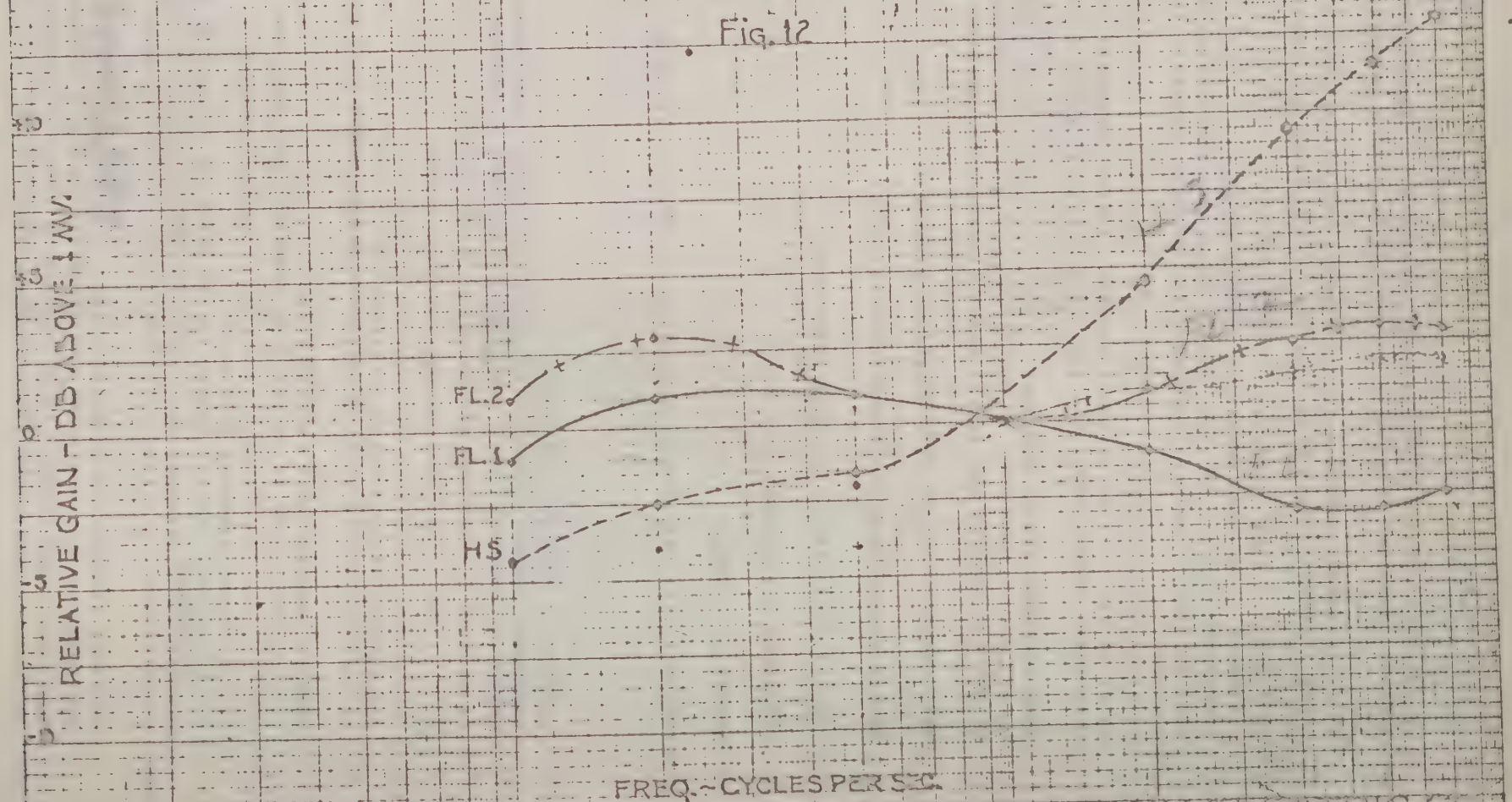
b. Feed a great enough signal from 22-ohm unbalanced source into MICROPHONE jack to yield "0VU".

c. With shaping switch on FL-1 and 1000-cps input, adjust RECord-REProduce LEVEL control and input signal to setting where meter reads zero VU. Record signal at slow speed.

SONA-GRAPH

OVERALL CHARACTERISTICS
(SEE SECTION VII C-10)

Fig. 12



KAY ELECTRIC CO.
PINE BROOK, N.J.

d. Set RECord-REProduce switch to REProduce position. Re-adjust RECord-REProduce LEVEL control to setting where meter reads approx. "0VU". Reproduce at high speed, measuring output at pin 2 of modulator. Plot curve of frequencies (100-8000 cps). SECTIONER ON

e. Repeat steps c & d for all frequencies in question. Note that for each new frequency recorded or reproduced, RECord-REProduce LEVEL control must not be changed. Output should follow curve on *figure 12*, coinciding with the *relative* values of this plot.

f. Set shaping switch to HS position. Repeat steps a to e on HS, check all outputs against curve in *figure 12*.

g. Set shaping switch to FL-2 position. Repeat steps a to e on FL-2. Check all outputs against curve in *figure 12*.

NOTE

If zero VU setting can not be obtained on REProduce for HS & FL-2 positions, select a lower (more negative) reading as a reference output and readjust RECord-REProduce level to this reading on each new frequency.

12. Marking Amplifier Gain and Bandwidth (V-12, 6SK7; V-16, 5L6).

a. Remove V-6 (6SN7).

b. SECTIONER switch OFF.

c. AGC pot (P-5) set to #1 (CCW) position.

d. RECord-REProduce knob in REProduce position.

e. MARK LEVEL pot (P-3) set completely clockwise.

f. Stylus not shorted and stylus wire (if any) clear of drum.

g. BAND SELECTOR set to NARROW. NOTE! IT IS NECESSARY T[illegible] VIB FOR PROPER BANDWIDTH & GAIN. VERY CRITICAL

h. Feed audio signal generator into TJ-5 with sufficient signal. (0.25 ±0.05 volts at 35 kc ±0.4) to produce 15-volt (approximately) output at TJ-2 (Ballantine).

i. Tune external generator frequency for maximum voltmeter reading (set input so maximum reading is 15V). Record input voltage, center frequency, and bandwidth (3 db down on either side of center).
(Bandwidth = 1000 ±150 cps.)

j. Check voltage divider R-49 (270K) and R-50 (30K) by connecting voltmeter or oscilloscope across stylus to ground and measuring 150 volts at 35 kc.

k. Typical Troubles: Incorrect bandwidths or center frequency may sometimes be corrected by retuning resonant circuit C-26 (900 mfd) and L-6 (20 mh).

)verall Gain and Bandwidth of 35 kc Amplifier and Marking Amplifier (V-10, 6SJ7; V-11, 6SJ7; V-12, 6SK7; V-16, 6L6).

. Remove V-6 (6SN7).

. SECTIONER switch OFF.

. AGC pot (P-5) set to #1, CCW.

. RECord-REProduce switch in REProduce position.

. MARK LEVEL pot (P-3) completely clockwise.

. Stylus not shorted and stylus wire clear of drum.

. Feed audio signal generator into terminal #2 of MOD. with sufficient signal (1 mv at 35 kc) to produce 16 volts output at TJ-2 (Ballantine).

. Tune generator for maximum voltmeter reading (with above input, output is 15 volts). Record center frequency, bandwidth (3 db either side of center), and input voltage for both wide and narrow band channels.

BAND	CENTER FREQUENCY	INPUT VOLTAGE	BANDWIDTH
arrow	35 kc ±0.4 kc	-4 to -1 db below 1 mv	130 ±30 cps
ide	35 kc ±0.4 kc	-4 to -1 db below 1 mv	700 ±150 cps

1MV = 1.5V APPROX. BANDWIDTH OK.

alance of MOD. to Variable Oscillator (V-6, 6SN7).

. RECord-REProduce switch in REProduce position. Replace V-6 (6SN7) & V-7 (6J5).

. RECord-REProduce LEVEL pot (P-1) completely counterclockwise.

. BAND SELECTOR switch on NARROW.

. SECTIONER switch off.

. AGC pot (P-5) at #1, (CCW).

. Ballantine connected to TJ-2.

. MARK LEVEL pot (P-3) at maximum.

. With oscilloscope connected to TJ-9, adjust P-7 (side of chassis) for 35 kc output.

. BAND SELECTOR to WIDE position.

. With MARK LEVEL below overload area, adjust P-4 (top of chassis) for minimum output (10 volts or less) at TJ-2. Return MARK LEVEL to max. and voltage should be 10 volts or less.

. If voltage is more than 10 volts, insert capacitor (200 to 1000$\mu\mu$f) from terminals 1, 3 or 6 to ground (reset P-4 for each added capacitor).

15. Variable Carrier Oscillator.

a. At TJ-9, measure carrier oscillator output (1 volt). APPRX 1

b. Connect VTVM from TJ-8 to ground.

c. Connect oscilloscope to TJ-9. As stylus is moved over the active 4 inches of pattern, frequency on scope should vary from 35 to 61.6 kc and the voltage at TJ-8 should increase (approx. 90-200 volts).

d. To zero adjust bottom of range at 35 kc.

1) Connect DC voltmeter to TJ-7.

2) Move stylus up until meter shows DC voltage.

3) Rotate drum by hand to exact point where voltage first appears.

4) Connect oscilloscope or a-c voltmeter to TJ-2.

5) Adjust P-7 for maximum indication. SLIDE

16. Frequency Range Adjustment.

a. Check stylus fixed resistance (R-201) by removing 8-pronged connector (J-203) and connecting ohmmeter between terminals 1 and 3. Resistance should be 10,000 ohms

b. Check stylus variable resistance for linear variation and continuity by connecting ohmmeter between terminals 2 and 3 or 2 and 1 and moving stylus up and down carefully. It may be necessary to clean resistor with fine crocus cloth. Apply light coat of oil or vaseline after cleaning. When stylus resistance is O.K., reconnect plug.

c. RECord-REProduce switch in REProduce position.

d. BAND SELECTOR in NARROW position.

e. SECTIONER switch OFF.

f. Ballantine and oscilloscope connected to TJ-2.

g. AGC control pot (P-5) at #1, CCW. MARK LEVEL maximum completely clockwise.

h. Connect d-c VTVM to test jack TJ-7 on the rear of the chassis.

i. With AGC pot at #1 and stylus just above lower short point, adjust P-7 for maximum carrier leakage (approx. 15 volts). 30 V

j. Move stylus up, just below upper short point. Connect signal generator tuned to 26.7 kc, to pin 2 of amplitude display connector on left side of chassis. Adjust for +3.0 "VU" input. Adjust P-6 for peak voltage at test jack J-2. 30 V ABOVE 1.222 V RMS

k. Remove signal generator from pin 2 and check for carrier leak at lower short limit by observing oscilloscope at TJ-2.

l. Repeat steps i, j and k until correct frequency limits are obtained.

n. Typical Troubles:

1) Attach oscilloscope to 10-μf coupler (C-53 on top of V-7 turret); check for carrier output.

2) P-7 gives more than one peak at TJ-2:

a) 3 peaks indicate MOD. 1 unbalance; repeat step 15.

b) 2 peaks indicate signal obtained either side of the 35-kc carrier (carrier up too high). The first peak obtained proceeding in a clockwise direction is the one that should be selected.

AGC Channel.

a. Wide.

1) RECord-REProduce switch in REProduce position.

2) BAND SELECTOR on WIDE.

3) Remove V-7 (6J5), set RECord-REProduce LEVEL pot (P-1) completely counterclockwise. Connect VTVM from top of AGC pot (P-5, top of chassis) to ground (P-5 set to #1).

4) With 0.1-volt, 35 kc (±1 kc) signal fed to terminal 2 of the modulator, negative output should appear at top of AGC pot (P-5).

5) Record negative output voltage as a function of the input (db above or below 1 mv).

b. Narrow. Same as a, but with BAND SELECTOR on NARROW and frequency input 35 ±0.4 kc.

dbm	INPUT db above or below 1 mv	OUTPUT - VOLTS Wide	Narrow
-62.8	-5	-1.2	-1.6
-52.8	0 (1 mv)	-1.5	-2.2
-52.8	+5	-2.5	-3.1
-42.8	+10	-3.5	-4
-[illegible]	+15	-4.5	-4.8
-32.8	+20 (10 mv)	-5.3	-5.7
-32.8	+25	-6.0	-6.6
-22.8	+30	-7.2	-8.0
-[illegible]	+35	-9.6	-10.2
-12.8	+40 (100 mv)	-12,9	-13.2

Overall Response of Record Amplifier, Head, Tape, Reproduce Amplifier, Modulator, Filter and Marking Amplifier.

a. RECord-REProduce switch on RECord.

b. Shaping switch on FL-1.

c. BAND SELECTOR on NARROW.

d. SECTIONER switch OFF.

e. AGC pot set to 4.5

f. Set MARK LEVEL at 7-½. Do not change this setting until test is completed.

g. Feed 1000 cps, 2 mv signal, into MICROPHONE jack.

h. Set RECord-REProduce LEVEL to obtain zero VU on meter. This should correspond to a setting of approximately "20".

NOTE: "0VU" and approx. corresponding setting of "20" on pot should be maintained when recording all frequencies (100 through 8000 cps).

i. Record input signal on tape.

j. Turn RECord-REProduce switch to REProduce.

k. Shift recorder speed shift lever to REProduce.

l. Increase RECord-REProduce LEVEL control to zero VU.

NOTE: A constant setting of pot should be maintained for reproducing all frequencies (100 thru 8000 cps). Disregard VU setting.

m. Connect Ballantine a-c meter to TJ-2.

n. With turntable in REProduce speed, raise stylus to a point where 100 cps would normally mark the paper. Note peaking of Ballantine (TJ-2) as stylus passes through this point.

o. With 100-cps input, record the voltage, in terms of db above 1 mv, at TJ-2 (see chart). If the recorded voltages do not correspond approximately to those below, use Ballantine to check voltages at terminal 2 of MOD. and TJ-10 in that order.

p. Repeat steps f through o for 200 cps, 300 cps and so on until entire range is covered. (Maintain 2 mv input).

OUTPUT	TJ-2*	TJ-10*	MOD. Term. #2*
100 cps	85.0 db	55.0 db	47.5 db
200 cps	86.0 db	57.0 db	48.0 db
300 cps	87.0 db	56.0 db	48.0 db
400 cps	87.0 db	56.0 db	48.0 db
500 cps	87.25 db	55.0 db	47.0 db
600 cps	87.0 db	54.0 db	47.5 db
700 cps	87.0 db	54.0 db	47.5 db
800 cps	87.25 db	54.0 db	47.5 db
900 cps	87.0 db	54.0 db	47.0 db
1000 cps	87.0 db	54.0 db	47.0 db
2000 cps	87.0 db	52.0 db	47.0 db
3000 cps	87.0 db	54.0 db	46.5 db
4000 cps	86.5 db	54.0 db	46.5 db
5000 cps	86.5 db	54.0 db	46.5 db
6000 cps	86.5 db	54.0 db	46.5 db
7000 cps	86.5 db	54.0 db	46.5 db
8000 cps	86.0 db	53.0 db	46.5 db

*±1.5 db

NOTE: A sharp drop in high frequency response would indicate head misalignment. A pronounced deviation from "0VU" (equal to a setting of approximately "20" on pot, step h) at all frequencies would indicate poor Record Amplifier response. Run checks 8 and 11.

Sectioner (Pull V-6 and V-7).

a. Set SECTIONER switch ON.

b. Set AGC pot (P-5) at #1, CCW.

c. Set BAND SELECTOR on NARROW.

d. Set RECord-REProduce LEVEL pot (P-1) completely counterclockwise.

e. Place RECord-REProduce switch in REProduce position.

f. Insert 5 equally spaced pins (12 holes) around drum.

g. Adjust Microswitch so that periphery of contact is tangent to center of outer holes and switch is tripped by pins.

h. Connect Ballantine to plate pin 8 of V-12.

i. Connect oscilloscope to TJ-2.

j. Set MARK LEVEL pot (P-3) to normal marking level (about 7-1/2).

k. Make certain stylus is not shorted.

l. Connect signal generator to TJ-5. Adjust to obtain 1-volt 35-kc signal at plate of V-12.

m. With table turning at high speed and pins tripping Sectioner microswitch, set potentiometer P-10 for 6-8 mm length pulse on paper at 1 volt 35-kc.

n. With stylus on paper, adjust P-11 to give a suitable marking intensity (MARK LEVEL pot at approximately 7-1/2). If last 1/4" of pulse trailing edge changes intensity, readjust P-11.

o. With 56 volts at plate of V-12, set P-9 for 41-43 mm pulse length.

p. Decrease output by 5-db steps and check Sectioner uniformity at each step.

q. Typical Troubles:

1) Pulse length cannot be decreased to 41-43 mm - leaky 0.02 μf capacitor (C-201).

2) Irregular Section - microswitch is bouncing and should be tightned down.

20. Wow. (Replace V-6 (6SN7) & V-7 (6J5).

a. Place RECord-REProduce switch in RECord position.

b. Set AGC pot (P-5) at #1, CCW.

c. Turn SECTIONER switch OFF.

d. Turn BAND SELECTOR to NARROW position.

e. Connect Audio signal generator fed into MICROPHONE jack at 7 kc and -3 VU level.

f. Record at low speed. Reproduce at high speed.

g. With MARK LEVEL at 7.5, make SONAGRAM by moving stylus until output is shown on oscilloscope.

h. If line waver on paper exceeds 1/16", peak-to-peak, check motor torque.

1) Remove speed shift lever and knob. Remove cover from unit. Reinsert speed shift lever.

2) Set speed shift lever to RECord position. Allow sufficient time for all moving parts to reach operating temperature.

3) To determine whether WOW is due to incorrect drive speed, stop turntable by holding index finger against periphery of turntable. Pull should be just sufficient to start turntable again after it has been stopped.

4) If pressure is too great, use Allen wrench to release 6/32 set screw on top of speed shift lever grommet and turn the 10/32 set screw clockwise until condition 3 is satisfied. Adjust slowly and check the unit after each adjustment. After optimum point has been found, lock in place by tightening 6/32 grommet screw.

5) If pressure is too slight, use Allen wrench to release 6/32 set screw on top of speed shift lever grommet and turn 10/32 set screw counterclockwise until condition 3) is satisfied. Adjust slowly and check unit after each adjustment. After optimum point has been found, lock in place by tightening 6/32 grommet screw.

6) If WOW still occurs after adjusting set screws, a replacement pulley should be ordered from the factory. In an emergency, the pulley may be ground to round.

7) Recurring cyclic bump in Sonagram usually indicates an out-of-round motor drive pulley. Pulley may be ground slightly to round.

NOTE

To prevent a flat from developing on the rubber wheel and causing WOW, the speed changer lever should always be left in OFF position when not in use.

Amplitude Display Unit Adjustment.

a. Set RECord-REProduce switch in REProduce position.

b. Set shaping switch in HS position.

c. Turn BAND SELECTOR switch in NARROW position.

d. Turn SECTIONER switch OFF; set MARK LEVEL normal at 7-1/2.

e. Turn AMPLITUDE DISPLAY switch ON

f. Wrap paper around drum and mark with pencil 1-3/4" from top of paper.

g. Raise stylus to a point 1-3/4" from top of paper. Do not allow stylus wire to touch drum.

h. Ballantine and oscilloscope connected to TJ-2. Set Ballantine on 10-volt range.

i. Set both pots P-401 and P-402 (in Amplitude Display Unit Box) fully counterclockwise.

j. Connect D-C VM to test jack on back of Amplitude Display. Adjust R-424 & R-425 to obtain +1.0 volt at this point.

k. While depressing baseline switch, turn R-424 & R-425 clockwise until first peak of 10 volts or more (as indicated on Ballantine) appears on oscilloscope.

IMPORTANT

Disregard all peaks of less than 10 volts. If D-C VM reaches +2.0V before 10-volt peak is reached, repeat steps i and k; i.e., increasing positive reading (D-C VM) with R-424 and decreasing positive reading (D-C VM) with R-425 watching oscilloscope and Ballantine until a peak greater than 10 volts is found.

l. Assume that this is the peak about 20 kc heterodyning with carrier at MOD. Release the baseline switch - pattern on oscilloscope should be reduced.

m. Depress baseline switch again. Peak should reappear. Release stylus and pass through 1-3/4" setting several times, looking for a high peak at this point only.

n. If peaks DO NOT disappear on steps l and m, repeat.

o. Tests should be made producing baseline first, then releasing switch to allow pattern to mark.

p. Make second Section at -10 db position. Pattern should be identical to and 3/8" below first pattern.

TABLE 1

D-C VOLTAGES

TUBE	CONDITION	PIN	VOLTAGE	PIN	VOLTAGE	PIN	VOLTAGE
V-1	1	3	2.0	8	80.0	7	100.0
V-2	1	8	17.0	5	13.0	3	129.0
V-2	2	8	7.0	5	3.6	3	62.0
V-3A	1	3	11.0	1	0.4	2	200.0
V-3A	2	3	8.7	1	0.3	2	150.0
V-3B	2	6	3.0			5	110.0
V-4	1	3	39.0	1	30.0	2	245.0
V-4	1	6	39.0	4	29.0	5	245.0
V-5	1	4	-40.0	1	-40.0	2/5	180.0
V-6	2,3	4	-20.0	1	-20.0	2/5	160.0
V-7	2	8	2.5			3	180.0
V-10	2	5	1.3	6	48.0	8	230.0
V-11	2	5	1.4	6	50.0	8	90.0
V-12	2,3	4	0	6	30.0	8	50.0
V-13B	3,4,5	3	2.5			2	170.0
V-14A	6	1	-4.0			2	170.0
V-14B	2,7	4	-15.0			5	125.0
V-15A	2,8	1	-2.0			2	70.0
V-15B	2,8	4	-20.0			5	80.0
V-16	2,3,8	8	16.0	4	240.0	3	240.0
V-17A	2	3	0.64 .69			2	95.0 110
V-17B	2	4	-0.55 -.71			5	35.0 32
V-18	2	4	-0.6 -.6	6	80 50	8	111.0 112
V-19	6,9	3	1.0 .75	4	2.5 2.6	8	1.0 .75

(All voltages measured with RCA Voltohmyst)

Conditions:

1. RECord-REProduce switch in RECord position. Shaping switch in FL-1.
2. RECord-REProduce switch in REProduce position.
3. Stylus not shorted.
4. MARK LEVEL pot, P-3, at maximum clockwise position. SECTIONER switch ON.
5. SECTIONER switch OFF.
6. P-10 at maximum clockwise position.
7. P-10 at maximum counterclockwise position.
8. AGC pot, P-5, at #1 position.

TABLE 2
SONA-GRAPH VOLTAGE GAINS

(ALL VOLTAGES MEASURED WITH BALLANTINE VOLTMETER USING SHORT LEADS.)

TUBE	INPUT PIN NO.	INPUT FREQUENCY	INPUT VOLTAGE	OUTPUT PIN NO.	OUTPUT VOLTAGE	REMARKS
V-1	CAP.	1000 CPS	2 MV	3	46 MV	RECORD INPUT THRU 0.1 μF CAP.
V-2	5	1000 CPS	1V	P-1	2.9V	
V-3A	CENTER P-1	1000 CPS	1V	TJ-10	2.85V	
V-3B	TJ-10	1000 CPS	1V	JUNCTION C-9/R-23	3.65V	
V-4	CENTER P-2	1000 CPS	1V	2	3.4V	NOTE 1
V-5				2	100V R-F	NOTE 1
V-5				5	100V R-F	NOTE 1
V-6				2	49V R-F	NOTE 4
V-6				5	48V R-F	NOTE 4
V-7	JUNCTION C-53/R-81	60 KC	10V	JUNCTION R-84/T-1	19.5 MV	NOTE 2
V-10	2 OF MOD	PEAK NEAR 35 KC	0.2V	8	18.0V	NOTE 2,3
V-11	PIN 7,T-8	PEAK NEAR 35 KC	0.2V	TJ-5	10.0V	NOTE 2,3
V-12	TJ-5	PEAK NEAR 35 KC	0.2V	8	4.5V	NOTE 6,2,5
V-13	1	1000 CPS	1.0V	2	25.0V	
V-14A	1	1000 CPS	1.0V	2	3.0V	
V-14B	4	1000 CPS	1.0V	5	30.0V	
V-15				P-11	36.0V	NOTE 7
V-16	JUNCTION C-25/R-42	PEAK NEAR 35 KC	1.0V	3	46.0V	
V-17A	1	35 KC	1.0V	2	24.0V	
V-17B	4	35 KC	1.0V	5	15.0V	
V-18	4	35 KC	0.1V	8	1.75V	

NOTES:

1. RECORD-REPRODUCE SWITCH (S-2) ON RECORD.
2. RECORD-REPRODUCE SWITCH (S-2) ON REPRODUCE.
3. BAND SELECTOR SWITCH ON NARROW.
4. STYLUS BELOW ACTIVE 4 INCHES OF PAPER (SHORTED).
5. STYLUS ON ACTIVE 4 INCHES OF PAPER (UNSHORTED).
6. MARK LEVEL CONTROL AT MAXIMUM.
7. SECTIONER ON. P-10 AT MAXIMUM CLOCKWISE POSITION.

SECTION VII

PARTS LIST

A. RECORDER (MECHANICAL UNIT
INAL MECHANICAL ASSEMBLY NO. 890)

Drive Assembly, #1357	Part No.
SHIFT LEVER ASSEMBLY, #628	
1 Shift Lever	628
1 Bearing Stud	566
80 1/16" Dia. Stainless Steel Balls	543
2 Inner Race for Balls	544
2 Outer Race for Balls	545
1 Spacer	634
2 Nuts	553
1 Plate, Motor Mounting	665
2 Screws, BHMS. 10-32 x 1/2	
MOTOR ASSEMBLY, #904S	
1 Motor	904
1 Aluminum Shaft	569
1 Plug, Amphenol, 86-CP8	920
1 Cap, Metal	919
DETAIL PARTS FOR DRIVE ASSEMBLY	
1 Strap Mtg. Microswitch	601
1 Plate, 0.015 Steel	670
1 Microswitch, MXL-1, S-202	902
1 Strap, Pulley, Short	589
1 Strap, Pulley, Long	591
2 Spacers, Brass	671
2 Shafts	644
2 Plastic Washers	924
2 Nickel-Silver Washers	576
2 Nickel-Silver Washers	577
2 Nickel-Silver Washers	995
2 Truarc Retaining C Washers	914
1 Drive Wheel, Ground with 1 Compo Bearing, Boston Oilless (Pressed), B 68-10	588 635
1 Drive Wheel, Ground with 1 Compo Bearing, Boston Oilless (Pressed), B 68-10	604 635
2 Compo Bearings	CS-182-6
1 Microswitch, S-205	950
1 Mounting Block	4302

Record & Pickup Assembly, #1358	
1 Mounting Block	614
1 Erase Arm	492
1 Record Arm	493

2. Record & Pickup Assembly, #1358 Cont'd.	Part No.
2 Bearing Pins	567
2 Springs	594
4 Screws, Ball Bearing Retainer	595
2 Screws, Spring Retainer	597
2 Gears (from Boston Gear 136)	598
1 Spacer, Record Head	664
2 Ratchet Pins	603
2 Springs, Arm Tension	615
28 3/64" Dia. Stainless Steel Balls	
4 5/32" Dia. Stainless Steel Balls	
2 10/32 Nuts	
1 #3 Ground Lug	
1 Allen Set Screw, 4-40 x 1/4, Cup Point	
1 Allen Set Screw, 4-40 x 1/8, Cup Point	
2 Screws, RHMS, 2-56 x 1/4	
1 Record Head (Brush Development Co. #BK985)	922
1 Erase Head (Brush Development Co. #BK1110A)	923
1 3-48 x 3/16 RHMS	

3. Stylus Resistor Assembly, #1359

a. COVER PLATE ASSEMBLY, #496

1 Cover Plate	496
2 Contacts, Shorting, Special	499
1 Terminal Plate	497
2 Spacers	498
1 Resistor, 10K, Wirewound, Spec., R-201	911
2 Screws, BHMS, 6-32 x 7/8	
2 Screws, BHMS, 6-32 x 1/4	
2 Nuts 6/32	
2 #6 Ground Lugs	

b. STYLUS ASSEMBLY, #500

1 Follower	500
1 Cam, Pivoting	520
1 Guide Post	519
1 Shaft	524
1 Spring, Coil	523
1 Half Nut	491
1 Pin, Stop	567
1 Tube, Insulating	579
1 Knob, Cam	571
1 Spring, Coil	525
2 Groove Pins	643
1 Nut	553
1 3/16" Dia. Stainless Steel Ball	
2 Screw, Brass, BHMS, 3-48 x 1/2	
1 Allen Set Screw, 6-32x1/8, Cup Point	

ylus Resistor Assembly, #1359 Cont'd. Part No.

ATE ASSEMBLY, #526

EARING PLATE	526
EAR (FROM BOSTON GEAR 129)	522
HAFT	524
PACING SHIM	
OMPO BEARING, BD.BRK.OILLESS, CS-24.3	494
ULLEY, V-GROOVE	521
ICRO BEARING, NEW HAMPSHIRE #24	593
LLEN SET SCREW, 6-32x1/8, CUP POINT	

ULATOR PLATE ASSEMBLY, #557

NSULATOR PLATE	557
NSULATOR TUBES	564
YELET LUGS	546

ULATOR PLATE ASSEMBLY, #562

SULATOR PLATE	562
NTACTS	596
RINGS	550
RINGS, COIL	534
ELETS, 1/8x3/16" DIA.	

IONER PLATE ASSEMBLY, #580

UNTING PLATE	580
ST, STOP	563
ARING STUD	572
OB	578
JUSTING ROD	581
OP FINGER	602
LER, STOP FINGER	618
RING PIN	619
DER SHOCK SLEEVE	583
ROSWITCH, MXQ-1-Z14	901
EW, FILHMS, 6-32x1/2	
EWS, BHMS, 4-40x7/8	
S, 4-40	
S, 10-32	
LOCKWASHERS	

S WIRE CLAMP ASSEMBLY, #587

O	587
ING	585
EW, ADJUSTING	573
, ADJUSTING	568
GROUND LUG	
EWS, RHMS, 2-56x1/8	

L PARTS, STYLUS RESISTOR ASSEMBLY

SING, CASTING	489
STOP, HEX	575
STUD, SECTIONER PLATE MTG.	629
STUD, LEAD SCREW BEARING ADJ.	495
NUT, SPECIAL	527
MICRO BEARING, NEW HAMPSHIRE #24	593
LEAD SCREW	605
GEAR (BOSTON GEAR 142 MACHINED)	592
WASHER, NICKEL SILVER	576
7 SCREWS, BHMS, 4-40x1/4	
SCREW, BHMS, 6-32x3/8	
LOCKSCREW	680
SHOCK SLEEVE	583
WASHER, CORK-RUBBER COMPOSITION	554

4. Frame Assembly, #1360

a. PLATE ASSEMBLY, #529

PLATE, MOUNTING	529
PLUG, JONES	P404SB
PLUG, JONES	P408SB
PLUG, JONES	P303AB
CONNECTOR, UG-262/U	204
SWITCH, SPST	255
6 SCREWS, BHMS, 4-40x1/4	
4 SCREWS, BHMS, 6-32x1/4	
6 NUTS, 4-40	
4 NUTS, 6-32	
5 #4 LOCKWASHER	
4 #6 LOCKWASHER	
1 #4 SOLDER LUG	
2 #6 SOLDER LUGS	

b. TERMINAL PLATE ASSEMBLY, #560

TERMINAL PLATE	560
4 TERMINALS	555

c. BEARING ASSEMBLY, #599

BEARING FRAME	599
PIN	600
ROLLER BEARING	574

d. DETAIL PARTS, FRAME ASSEMBLY, #1360

TOP SIDE

BASE CASTING	400
GROMMET, SHIFT LEVER ADJUSTMENT	528
WIPER, FELT	553
WIPER SUPPORT	561
4 SPACERS	610
3 STAND-OFF POST	260
3 100 OHM, 1/2 WATT RESISTORS	

TOP SIDE Cont'd.	Part No.
1 Allen Set Screw, 10-32 x1/2, Flat Point	
1 Allen Set Screw, 6-32x1/8, Cup Point	
1 Capacitor, 300μμf	
BOTTOM SIDE	
5 Spacers, Plate Mounting	617
2 Shafts	645
6 Screws, BHMS, 8-32x3/4	
1 Terminal Strip, Clinch Type	264
1 Buzzer, D.C. Edwards	951
1 Transformer, Fil. Chicago #6134 T-201	952
2 Spacers, Brass	928
4 #4 Lockwashers	
2 #10 Lockwashers	
4 Screws, BHMS, 4-40x7/8	
1 Screw, RHMS, 10 x 1 1/2	
1 Screw, RHMS, 10 x 1	
1 Screw, FHMS, 4-40x1	
5 Screws, FHMS, 6-32x1	
5 Nuts, 6-32	
5 6-32 Lockwashers	
1 #6 Ground Lug	

Turntable Assembly, Main, #1361

TURNTABLE ASSEMBLY, #607

1 Turntable	607
1 Pulley, V-Groove	621
1 Shaft	620
1 Plug	625
1 Drive Belt	627
1 Main Bearing Assembly, Compo Bearings Installed	624

DRUM ASSEMBLY, #609

1 Shell	609
1 Plate, Bottom	622
1 Plate, Top	623
2 Springs, Coil, Paper Retaining	533
3 Studs	551
1 Pin, Index, Machined	672
3 Screws, BHMS, 10-32x1/2, Chrome Plated	

Detail Parts, Final Mechanical Assembly #890

1 Nut	553
1 Rod Lever	565
4 Washers, Nickel Silver Spring Temper	576
1 Tie Rod	616
4 Spacers	667
2 C-Washers	914
2 Washer, Plastic, 3/8x5/8x.030	924
1 Knob	908
5 Clamps, Plastic	325

6. Detail Parts, Final Mechanical Assembly, #890 Cont'd.	Part No.
1 Clamp, Stylus Cable	501
1 Socket (Kay #253 Black Octal)	921
2 Washers, Nickel Silver Spring Temper	577
2 Spacers, Plug Mounting	928
2 Screws, RHMS, 4-40x7/8	
2 Screws, RHMS, 10-32x1	
4 Screws, FHMS, 10-24x1/2	
4 Screws, BHMS, 8-32x5/8	
1 Screw, BHMS, 6/32x1/4	
2 Screws, BHMS, 6-32x1	
1 Screw, BHMS, 10-32x1/4	
1 Capacitor 5μf	906
1 Screw, BHMS, 6-32x3/16	
4 Screws, FILHMS 6-32x1	
5 Screws, FILHMS 10-32x5/8	
2 Springs	535
1 Lock Nut	558
8 Screws, BHMS, 4-40x1/4	
1 Screw, BHMS, 6-32x1/2	
2 Pins, Block Guide	584
6 Tripping Pins	590
2 Special Spring Washers N/S	995
1 Plate Bakelite	612
1 Spacer, Bakelite	556
1 #10 Washer, Bakelite	

B. AMPLIFIER-ANALYZER

1. Mechanical Parts	Part No.
a. AMPLIFIER-ANALYZER CHASSIS WIRED #395	
1 Chassis, Amplifier-Analyzer	433
1 Panel for Chassis	434
1 Sloping Front	435
1 Panel for Sloping Front	436
1 Pilot Lite Holder	248
1 Pilot Lite, I-1	249
1 Connector, UG-185/U, J-5	204
1 Speaker Screen, 4" x 4"	1430
1 VU Meter, M-1	1431
1 Flexible Coupling, Millen	214
1 5" Speaker	1003
1 Socket, Jones S306FP J-9	222
1 Socket, Jones S404SB J-3	224
1 Plug, Jones P410SB J-4	432
1 Socket, Jones S408SB J-1	226
1 Socket, Jones S303AB J-2	217
9 Chassis Jack, Red	447
1 Chassis Jack, Black	448
2 Rotary Switch, S-3, S-4	445
1 Rotary Switch, S-1	446
1 Rotary Switch, S-2	443
1 Switch Mounting Bracket	441
1 Microphone Jack, JK34A J-8	449
8 Knobs, 1" Pointer	166

chanical Parts Cont'd.	Part No.
Pot Dial, Calibrated 1-10	1432
Spacer, Varistor	1009
Grommet, Rubber	341
Terminal Post Standoff	260
Switchable Filter Assembly, Wired	1364
Aux. Speaker Jack, J-7	
Varistor 45E	294
NAL ASSEMBLY #403	
Final Mechanical Assembly	890
Cabinet, Mechanical Unit	405
Cover, Large, Screened, Mechanical Unit	406
Cover, Small, Mechanical Unit	407
Indicator Assembly	549
Plastic Tube, Stylus	409

1. Mechanical Parts Cont'd.	Part No.
1 Blower Motor Assembly	1206
6 Bumpers, Rubber	412
1 Inspection Plate Top, Mechanical Unit	413
1 Stylus Wire Clamp	501
1 Power Supply, Wired	360
1 Cover Top, Power Supply	415
2 Handles	424
1 Bottom Cover, Power Supply	400
1 Analyzer Electrical Chassis, Wired	395
1 Top Cover, Amplifier-Analyzer	416
1 Bottom Cover, Amplifier-Analyzer	359
1 Cable Assembly	1075
1 Cable Assembly	1076
1 Cable Assembly	1077
1 Cable Assembly	1078
1 Cable Assembly	1079
1 Microphone Assembly, Altec	1330

ectrical Parts.

ESISTORS (UNLESS OTHERWISE SPECIFIED, ALL COMPONENTS ARE FIXED ½ WATT, 10% TOLERANCE COMPOSITION, RESISTORS).

1	10K	R-27	15K
2	47K, 1W	R-28	220
3	120K, 1W	R-29	1.5K
4	220	R-30	330
5	470	R-31	15K
6	220	R-32	470K
7	470K	R-33	470
8	7.5K	R-34	6.8K
9	33K, 1W	R-35	470K
10	47K, 1W	R-36	100K
11	220	R-37	680
12	3K	R-38	220
13	220	R-39	220
14	1M	R-40	100K
15	2.2K	R-41	82K
16	7.5K	R-42	220
17	18K	R-43	15K
18	33K, 1W	R-44	500, 5W
19	4.7K	R-45	220
20	27K, 1W	R-46	220
21	470K	R-47	47K, 2W
22	680	R-48	360, 2W
23	180K	R-49	270K
24	20K	R-50	30K
25	18K	R-51	360, 2W
26	1.5K	R-52	120K
		R-53	5.6K
		R-54	10K
		R-55	3K
		R-56	470
		R-57	680
		R-58	1.5K
		R-59	47K
		R-60	47K
		R-61	15K
		R-62	27K
		R-63	15K
		R-64	4.7K
		R-65	470K
		R-66	680K
		R-67	3.3K
		R-68	3.3K
		R-69	240
		R-70	100K
		R-71	100K
		R-72	240
		R-73	470K
		R-74	22K
		R-75	4.7K, 1W
		R-76	150K
		R-77	470K
		R-78	39K
		R-79	39K
		R-80	39K
		R-81	470K
		R-82	470K
		R-83	180K
		R-84	220
		R-85	220
		R-86	10K
		R-87	510
		R-88	22K
		R-89	100K
		R-90	1M
		R-91	82K
		R-92	27K
		R-93	470K
		R-94	270K
		R-95	15K
		R-96	15K
		R-97	150K
		R-98	47K
		R-99	1.5K
		R-100	3.3K
		R-101	3.3K
		R-102	120K
		R-103	33
		R-104	1.2M

2. Electrical Parts Cont'd.

RESISTORS CONT'D.

R-105	100K	R-111	5.6M	R-117	100K	R-123	39K
R-106	560K	R-112	220K	R-118	2.2M	R-124	47K
R-107	82K	R-11	39K	R-119	470K	R-125	47K
R-108	62K	R-114	82K	R-120	1.2M	R-126	100K
R-109	430K	R-115	82K	R-121	100K	R-127	220
R-110	560K	R-116	1.2M	R-122	470K	R-128	22K

CAPACITORS (ALL VALUES IN μμF UNLESS OTHERWISE INDICATED)

C-1	DUAL ELECTROLYTIC, 2 x 20 μF, 450V	C-39	.01 μF, 300V, MICA OR PAPER
C-2	25 μF, 25V, ELECTROLYTIC	C-40	8200, 100V, MICA
C-3	NOT USED	C-41	.01 μF, 300V, AG-MICA
C-4	0.1 μF, 400V, PAPER	C-42	100, 300V, AG-MICA
C-5	DUAL ELECTROLYTIC 2 x 20 μF, 450V	C-43	300, 300V, AG-MICA
C-6	.05 μF, 400V, PAPER	C-44	400, 300V, AG-MICA
C-7	175, 500V, CERAMICON	C-45	0.1 μF, 400V, MET. PAPER
C-8	DUAL ELECTROLYTIC, 2 x 20 μF, 450V	C-46	0.1 μF, 400V, PAPER
C-9	0.25 μF, 200V, MET. PAPER	C-47	2400, 300V, AG-MICA
C-10	.01 μF, 500V, AG-MICA	C-48	91, 300V, AG-MICA
C-11	25 μF, 25V, ELECTROLYTIC	C-49	91, 300V, AG-MICA
C-12	5600, 300V, AG-MICA	C-50	.01 μF, 300V, MICA
C-13	100, 500V, AG-MICA	C-51	50, 500V, CERAMIC
C-14	7-45 VARIABLE, ERIE N500	C-52	0.1 μF, 400V, PAPER
C-15	7-45 VARIABLE, ERIE N500	C-53	10, 500V, CERAMICON
C-16	.05 μF, 200V, MOLDED PAPER	C-54	50, 500V, CERAMIC
C-17	.01 μF, 300V, AG-MICA	C-55	0.25 μF, 200V, PAPER
C-18	DUAL ELECTROLYTIC, 2 x 20 μF, 450V	C-56	0.1 μF, 400V, PAPER
C-19	20 μF, 25V, ELECTROLYTIC	C-57	0.1 μF, 400V, PAPER
C-20	300, 300V, AG-MICA	C-58	390, 300V, MICA
C-21	25 μF, 25V, ELECTROLYTIC	C-59	0.1 μF, 400V, PAPER
C-22	2000, 500V, CERAMICON, HI-K	C-60	390, 300V, MICA
C-23	.01 μF, 200V, AG-MICA	C-61	.02 μF, 500V, DISC CERAMIC
C-24	.01 μF, 400V, PAPER	C-62	0.1 μF, 400V, PAPER
C-25	125, 500V, CERAMICON ERIE HI-K	C-63	2000, 300V, AG-MICA
C-26*	850, 300V, AG-MICA	C-64	.02 μF, 600V, PAPER
C-27	0.25 μF, 300V, MET. PAPER	C-65	.01 μF, 300V, PAPER
C-28	0.1 μF, 400V, PAPER	C-66	20 μF, 250V, ELECTROLYTIC
C-29	150, 300V, AG-MICA	C-67	0.1 μF, 400V, PAPER
C-30	300, 300V, AG-MICA	C-68	470, 300V, MICA
C-31	.01 μF, 300V, AG-MICA	C-69	50, 500V, CERAMIC
C-32	.01 μF, 300V, AG-MICA	C-70	0.1 μF, 400V, PAPER
C-33	100, 300V, AG-MICA	C-71	50, 500V, CERAMIC
C-34	7-45 VARIABLE, ERIE N500	C-72	800, 300V, MICA
C-35*	5000, 300V, AG-MICA	C-73	150, 500V, AG-MICA
C-36*	62, 300V, AG-MICA	C-74	1000, 300V, AG-MICA
C-37	7-45 VARIABLE, ERIE N500	C-75	.01 μF, 500V, DISC CERAMIC
C-38	.01 μF, 300V, AG-MICA		

SWITCHES

S-1	ROTARY, 3-WAFER, SHAPING	S-4	ROTARY, 5-WAFER, SECTIONER
S-2	ROTARY, 8-WAFER, REC-REPR.	S-5	DPDT TOGGLE, ON-OFF
S-3	ROTARY, 7-WAFER, BAND SELECTOR	S-6	DPST, MOMENTARY, OSC. DISABLE

ctrical Parts Cont'd.

NNECTORS

1 RECEPTACLE, JONES S406SB ✓
2 RECEPTACLE, JONES S303AB, MICROSWITCH ✓
3 RECEPTACLE, JONES S404SB, HEADS ✓
4 RECEPTACLE, JONES P410SB, POWER ✓
5 RECEPTACLE, BNC TYPE UG-185/U, STYLUS ✓
6 RECEPTACLE, TELEPHONE, JK34A, MICROPHONE ✓
7 RECEPTACLE, SWITCHCRAFT 12A, AUX SPKR
8 NOT USED
9 RECEPTACLE, JONES S306FP, AMP. DISPLAY ✓

OTENTIOMETERS (MAXIMUM RESISTANCE LUES INDICATED)

1 250 K, DAVEN, 2 DB STEP, REC-REP LEVEL
2 500 K, MONITOR GAIN
3 500 K LINEAR MARK LEVEL
4 60, LINEAR, MOD. BALANCE ADJ.
5 200 K, LINEAR AGC
6 10 K, LINEAR, VAR. OSC. ADJ.
7 DUAL POT, 2 x 10K, VAR. OSC. ADJ.
8 NOT USED
9 500 K, LINEAR, LONG SECTIONER PULSE ADJ.
10 250 K, LINEAR, SHORT SECTIONER PULSE ADJ.
11 1 MEG, LINEAR, MARK INTENSITY

ISCELLANEOUS

1 THRU D-4 1N305
5 THRU D-6, GERMANIUM CRYSTAL DIODE 1N294
1 PANEL LIGHT, 6.3 VAC, BAYONET ✓
1 SIMPSON VU METER MODEL 1047 ✓
1 SPECIAL, BANDPASS FILTER, 45/300 CPS BAND ABOUT 35 KC.

ORY-SELECTED; VALUES SHOWN ARE AVERAGE.
ICATE LISTING. SEE MECHANICAL PARTS LIST

COILS

L-1 6.5 MH, TOROIDAL, C-1 CORE, TOROCOIL
L-2 20 MH, TOROIDAL, C-1 CORE, TOROCOIL
L-3 100 MH, TOROIDAL, C-1 CORE, TOROCOIL
L-4 500 MH, TOROIDAL, C-1 CORE, TOROCOIL
L-5 2 MH, TOROIDAL, C-1 CORE, TOROCOIL
L-6 20 MH, TOROIDAL, C-1 CORE, TOROCOIL
L-7 100 MH, TOROIDAL, C-1 CORE, TOROCOIL
L-8 10 MH, TOROIDAL, C-1 CORE, TOROCOIL
L-9 100 MH, TOROIDAL, C-1 CORE, TOROCOIL

TRANSFORMERS

T-1 SPECIAL 35-61.6 KC, TOROIDAL, C-1 CORE
T-2 INPUT, AUDIO, UTC HA100X
T-3 TOROIDAL, C-4 CORE; CENTER-TAPPED PRI, 0.5 MH EACH SIDE; SEC, 5 MH (75 KC)
T-4 TOROIDAL, C-4 CORE; STEP-UP; PRI, 17 MH; SEC, 34 MH, (35 KC)
T-5 OUTPUT, AUDIO, STANCOR 3496A

ELECTRON TUBES

V-1	5879	V-11	6SJ7
V-2	6J5	V-12	6SK7
V-3	6SN7	V-13	6SL7
V-4	6SN7	V-14	6SL7
V-5	6BL7	V-15	6SN7
V-6	6SN7	V-16	6L6
V-7	6J5	V-17	6SL7
V-8	NOT USED	V-18	6SJ7
V-9	NOT USED	V-19	6H6
V-10	6SJ7		

C. Power Supply

Transformers

T-301	KP-91 Industrial
T-302	Filament
T-303	KP-51 Industrial

Chokes

L-301	10 henry, 150ω, 0.1 ampere
L-302	10 henry, 150ω, 0.1 ampere

Tubes

V-301	5R4 or 5U4	V-305	VR150 or OD3
V-302	6Y6	V-306	6SN7
V-303	6Y6	V-307	1852 or 6AC7
V-304	6SL7 or 6SU7		

Resistors (Unless otherwise specified, all resistors 1/2 watt, and all values in ohms.)

R 301	330K	R-313	10K, 2 watts
R-302	390	R-314	2.7K
R-303	51, 1 watt	R-315	82K, 1 watt
R-304	100, 1 watt	R-316	68K
R-305	220	R-317	10K, 1 watt
R-306	390	R-318	82K
R-307	51, 1 watt	R-319	1.5M
R-308	120K	R-320	33K, 1W
R-309	270K	R-321	47K, 1 watt
R-310	100, 1 watt	R-322	220
R-311	220	R-323	560K
R-312	120K	R-324	1M
		R-325	4.7K

Capacitors

C-301	20 μf, 500V, Electrolytic
C-302	20 μf, 500V, Electrolytic
C-303	2 μf, 600V
C-304	0.01 μf, 600V
C-305	0.5 μf, 600V
C-306	20 μf, 450V, Electrolytic
C-307	0.5 μf, 400V
C-308	1 μf
C-309	2 μf, 600V
C-310	0.01 μf, 500V
C-311	20 μf, 450V, Electrolytic
C-312	1 μf, 600V

Potentiometer

P-301	25K, 2 watts, Type J

AMPLITUDE DISPLAY UNIT.-

Tubes

V-401	6SL7	V-402	6SL7

Resistors (All resistors 1/2 watt, values in ohms.)

R-401	39K	R-412	51K
R-402	18K	R-413	270K
R-403	18K	R-414	1.2M
R-404	1K	R-415	1.5M
R-405	100K	R-416	5.6M
R-406	47K	R-417	1.2M
R-407	22K	R-418	82K
R-408	10K	R-419	510K
R-409	10K	R-420	39K
R-410	10K	R-421	39K
R-411	51K	R-422	39K
		R-423	270K

Potentiometers

P-424	50K, Bias Adjust (Internal)
P-425a	100K, Frequency Adjust (Internal)
P-425b	100K, Frequency Adjust (Internal)

Diodes

D-401	1N294	Raytheon Germanium Crystals
D-402	1N294	Raytheon Germanium Crystals
D-403	1N294	Raytheon Germanium Crystals

Switches

S-401a, b and c	Rotary, ON-OFF, -10 db, Cable Switch
S-402	S.P.S.T., ON-OFF, Momentary Switch

Coils

L-401 Stancor Choke, 4-14,000 ohms, Push-Pull Single Plate

Capacitors

C-401	.03 µf, 450V	C-406	30 µµf, 450V
C-402	25 µf, 25V, Electro.	C-407	0.1 µf, 450V
C-403	0.1 µf, 400V	C-408	750 µµf, 450V
C-404	0.05 µf, 400V	C-409	20 µf, 450V
C-405	30 µµf, 450V		

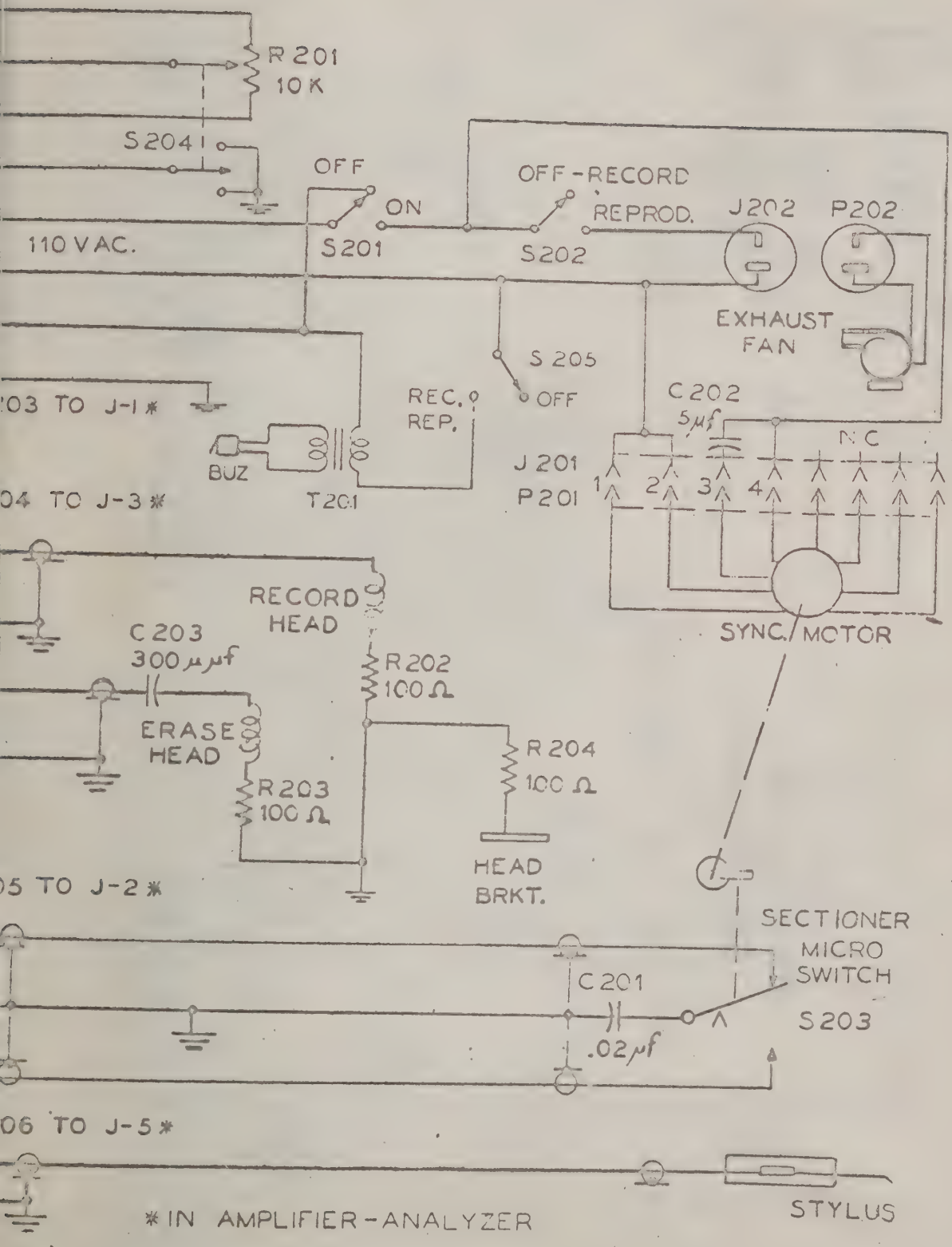


Fig. 14, Complete Schematic Diagram, Recorder Unit

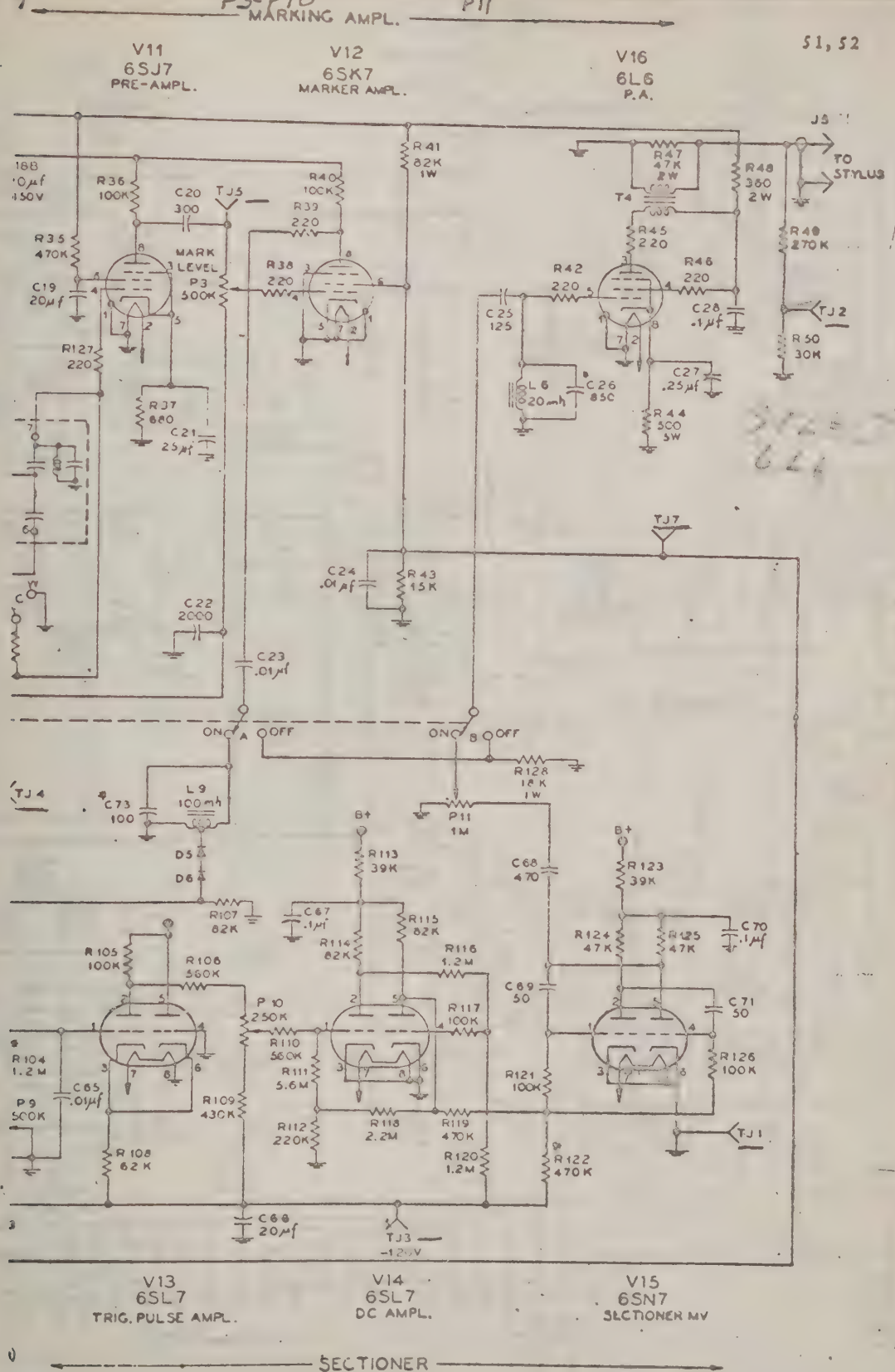
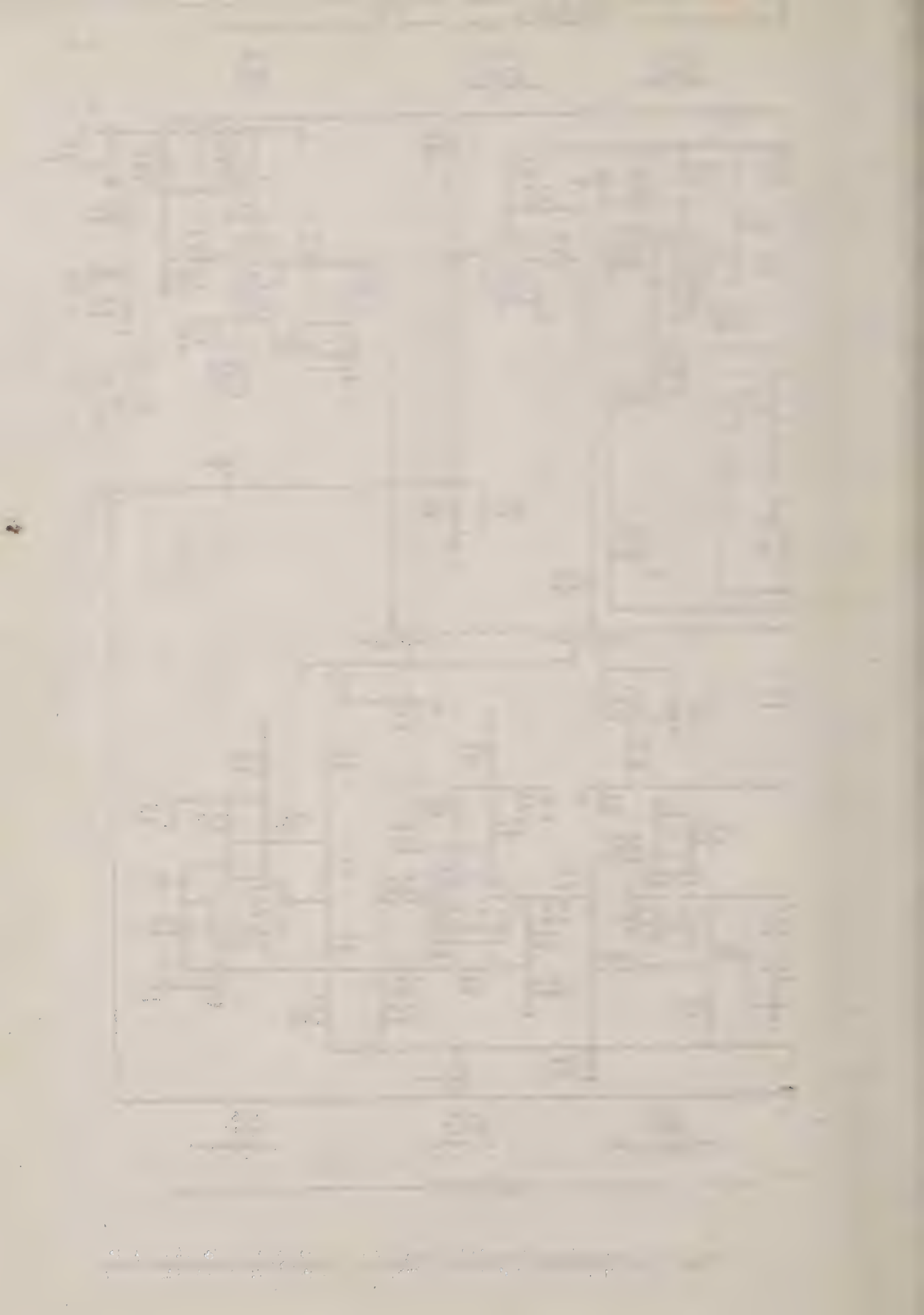
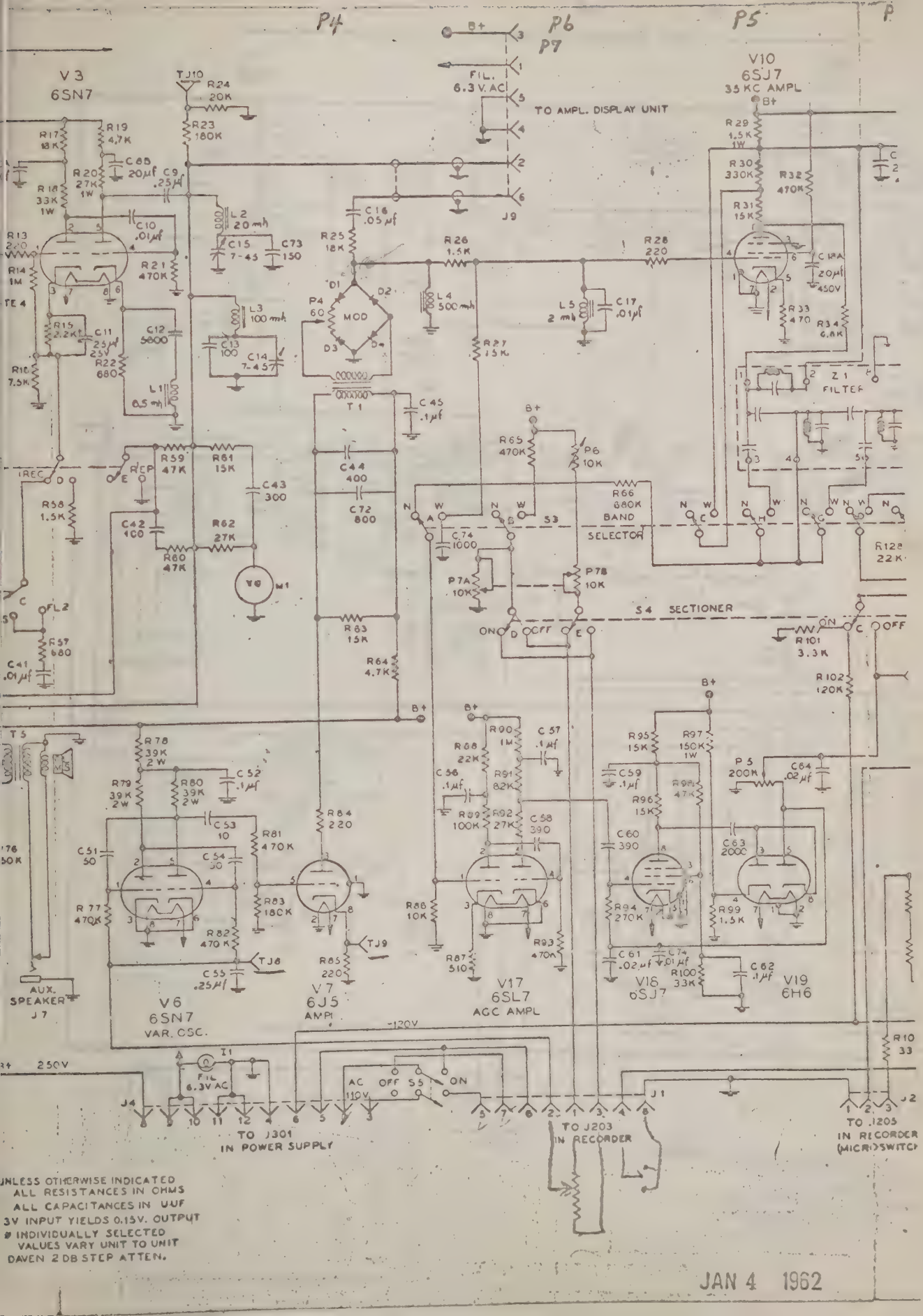
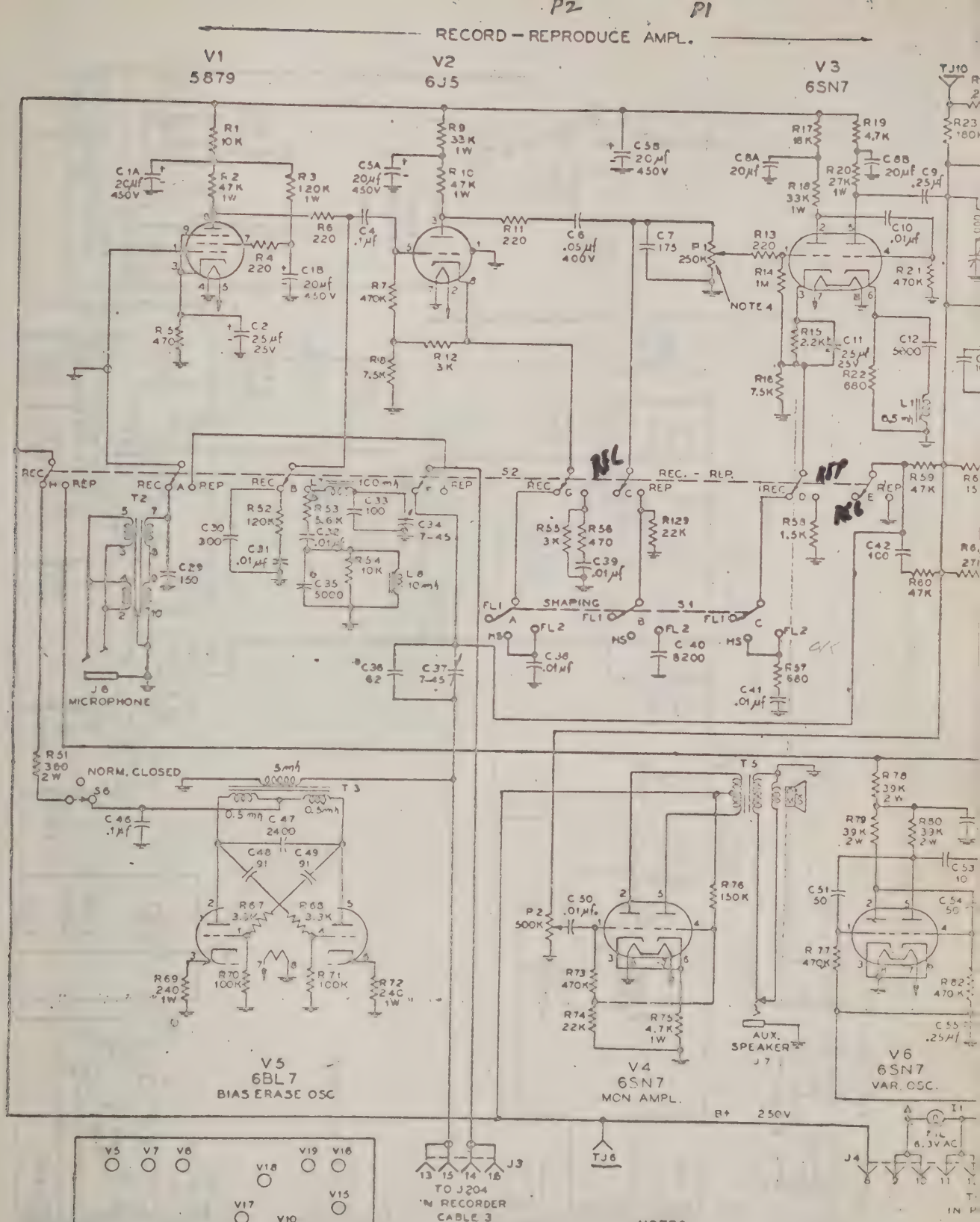


Fig. 15, Complete Schematic Diagram, Amplifier-Analyzer Unit




P4
P6
P7
P5
V3
6SN7
V10
6SJ7
35 KC AMPL
TO AMPL. DISPLAY UNIT
FIL.
6.3 V. AC
J9
T1
MOD
S3
BAND
SELECTOR
S4 SECTIONER
Z1
FILTER
V6
6SN7
VAR. OSC.
V7
6J5
AMPL
V17
6SL7
AGC AMPL
V18
6SJ7
V19
6H6
AUX.
SPEAKER
J7
-120V
250V
J4
J1
J2
TO J301
IN POWER SUPPLY
TO J203
IN RECORDER
TO J205
IN RECORDER
(MICRO)SWITCH
UNLESS OTHERWISE INDICATED
ALL RESISTANCES IN OHMS
ALL CAPACITANCES IN UUF
3V INPUT YIELDS 0.15V. OUTPUT
INDIVIDUALLY SELECTED
VALUES VARY UNIT TO UNIT
DAVEN 2 DB STEP ATTEN.
JAN 4 1962


RECORD – REPRODUCE AMPL.
V1
5879
V2
6J5
V3
6SN7
REC – REP
S2
SHAPING
S1
J6
MICROPHONE
NORM. CLOSED
S6
T3
T5
AUX. SPEAKER
J7
V5
6BL7
BIAS ERASE OSC
V4
6SN7
MON AMPL.
V6
6SN7
VAR. OSC.
B+ 250V
TJ6
J3
13 15 14 16
TO J204
IN RECORDER
CABLE 3
J4
6.3V AC
V5 V7 V8 V19 V16 V18 V15 V17 V10 V11 V3 V14 V4 V1 V2 V12 V13
NOTES
1 UNLESS OTHERWISE INDICATED
ALL RESISTANCES IN OHMS
ALL CAPACITANCES IN UUF
2 3V INPUT YIELDS 0.15V. OUTPUT
3 # INDIVIDUALLY SELECTED
VALUES VARY UNIT TO UNIT
4 DAVEN 2 DB STEP ATTEN.

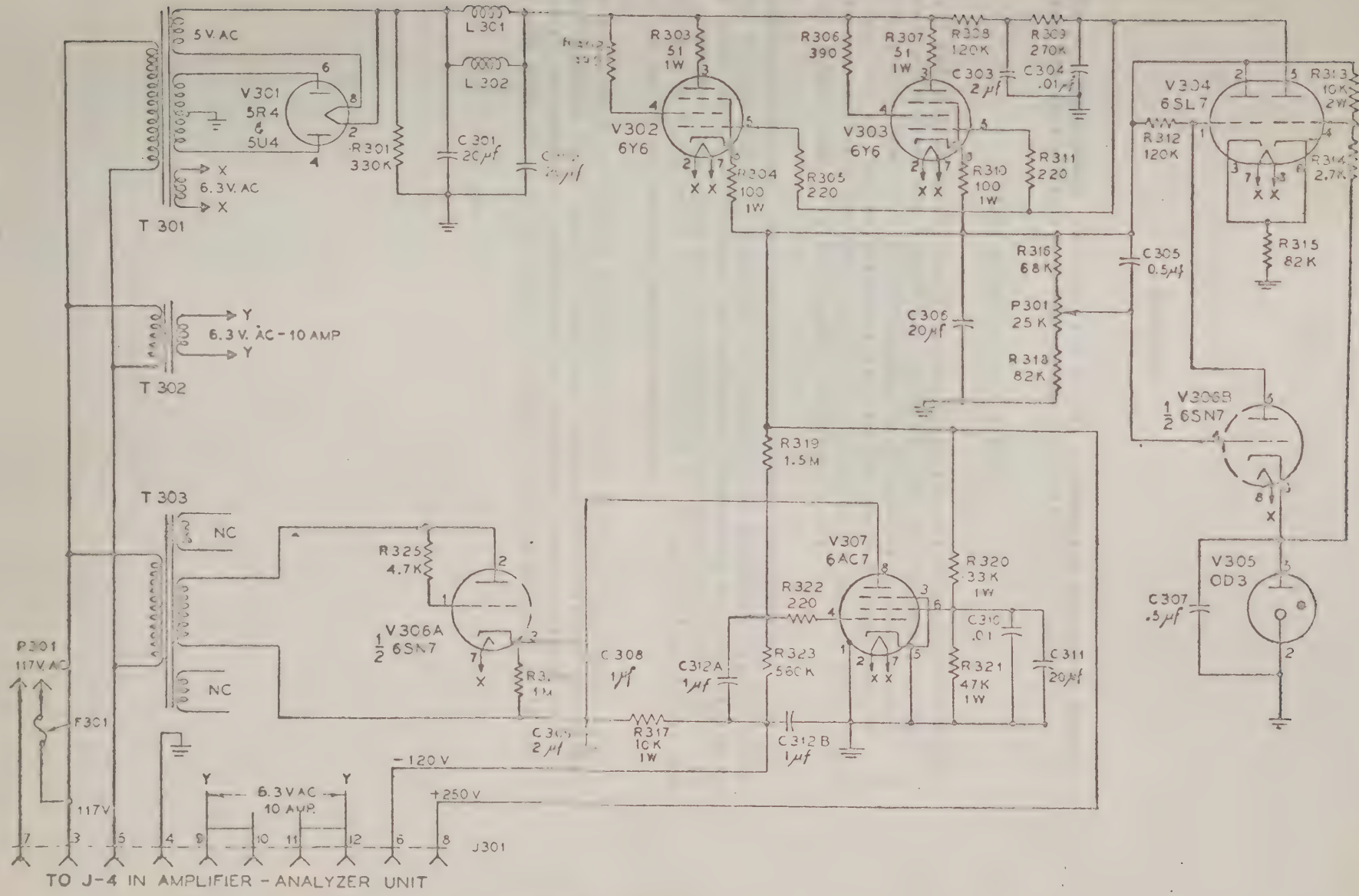


Fig. 16, Complete Schematic Diagram, Power Supply

ADDENDUM

The new SONA-GRAPH, to which all of the information contained herein applies, was developed from a SONA-GRAPH which differs as follows:

THREE MAJOR CIRCUIT CHANGES

1. BIAS-ERASE OSCILLATOR, now a single 75 kc sinusoidal output for bias and erase well above the significant harmonics of the highest recorded frequency, was formerly a dual-frequency oscillator with plug-in coil tuned for 13.5 kc for the erase and 40.5 kc for the recording bias. The signal-to-noise ratio has been improved over the older unit as well, thru the use of increased bias and higher recording levels.

2. MODULATION SYSTEM. A single modulation scheme incorporating a 35 to 61.6 kc variable carrier and 35 kc IF replaces the double modulation system of the older unit facilitating the alignment procedures and simplifying the mixer circuitry. The older unit variable carrier oscillator ran from 55 to 81.6 kc with a first IF of 55 kc, a second IF of 20 kc, a 20 kc filter and a final 40 kc (20 kc doubled) marking amplifier.

3. An accurately calibrated stepped attenuator replaces the former RECord-REProduce Level control which was continuously variable. The range of the new attenuator is calibrated in 2 db steps from zero to 32 db, 6 db steps from 32 to 44 db and in a single 10 db step from 44 to 54 db.

JAN 9 1959

September 24, 1957

INSTRUCTION MANUAL

for the

AMPLITUDE DISPLAY UNIT

KAY ELECTRIC COMPANY

ine Brook, N. J.

CA 6-4000

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SECTION I
GENERAL DESCRIPTION

APPLICATION.

The AMPLITUDE DISPLAY unit is an accessory instrument for use with Kay spectrum alyzers. This unit displays the output of the *Sona-Graph* and the *Vibralyzer* in decibels time on the upper third of the same paper as the other analyses. This is a desirable ature in applications where the measurement of the average amplitude of the recorded gnal is important. The amplitude display method provides a more accurate means of asuring the level of the recorded signal. On the standard graphic representations, e amplitude is a function of the coloring density, up to a 6 db level, of the recorded formation and as such is difficult to interpret with any degree of accuracy.

To overcome this difficulty the Amplitude Display system was designed. This method cords the signal level as a function of height, which can then be interpreted with a ir degree of accuracy.

FEATURES.

The AMPLITUDE DISPLAY unit is supplied with a single power cable for connection to ie *Sona-Graph* or the *Vibralyzer*. These units can then be used to provide the two tandard records plus an amplitude versus time record of the overall sample in db. To ccomplish this last recording operation, the signal sample stored on the magnetic eriphery of the turntable is fed thru the AUDIO AMP. to the AMPLITUDE DISPLAY unit here its level controls the frequency of a constant amplitude oscillator. The analyzing ection of the *Sona-Graph* or the *Vibralyzer* then produces a record of this oscillator's requency excursion versus time.

SPECIFICATIONS.

Height of amplitude versus time record: 1 inch approximately.

Intensity Range: 24 db or 34 db compressed.

Time length of record: *Sona-Graph* - 2.4 seconds, *Vibralyzer* - 2.4, 6.6, 20 seconds.

Power Consumption: 7 watts.

Dimensions: 11½" x 7½" x 6¼"

Weight: 7 lbs.

TUBE COMPLEMENT

TWO VACUUM TUBES AND THREE DIODES ARE EMPLOYED AS FOLLOWS:

SCHEMATIC SYMBOL	JAN TYPE DESIGNATION	FUNCTION (SEE ALSO WIRING SCHEMATIC, FIG. #3)
V-401	6SL7	Used to amplify and detect the output from the *Sona-Graph* or the *Vibralyzer*.
V-402	6SL7	Frequency Modulated Oscillator.
D-401	1N294	Logarithmic detector.
D-402	1N294	
D-403	1N294	

EQUIPMENT SUPPLIED.

1. AMPLITUDE DISPLAY.
2. Instruction Book.
3. Interconnecting cable with two 6-prong Jones plugs, one female, one male.
4. One six prong Jones plug, wired.

SECTION II
INSTALLATION

GENERAL.

The AMPLITUDE DISPLAY is designed for table top operation and thus presents no special installation problems. However to insure optimum operation the equipment should not be subjected to excessive moisture, vibration or temperature conditions.

If the AMPLITUDE DISPLAY unit is ordered in conjunction with the *Sona-Graph* or the *Vibralyzer* the only installation requirement is the matching of the plugs with their respective jacks. However, if the AMPLITUDE DISPLAY unit is ordered separately, the jumper wire located between *C-9* And *C-16* in the *Sona-Graph* or between pin 7 on *T-2* the modulating transformer, and *C-60* in the *Vibralyzer* must be removed. With this jumper removed, the AMPLITUDE DISPLAY unit or the special Jones shorting plug supplied with the unit must be inserted in the AMPLITUDE DISPLAY jack on the *Vibralyzer* or the *Sona-Graph*. If neither plug is inserted the analyzers will not operate.

INTERCONNECTION DATA.

The connections of the AMPLITUDE DISPLAY unit to the *Sona-Graph* or the *Vibralyzer* can be easily understood by referring to figure #1, the interconnection block diagram.

1. Connect the power supply cable to the amplifier-analyzer.
2. Connect the following cables from the amplifier-analyzer to the recorder.
   a. Head cable.
   b. Recorder power cable.
   c. Stylus cable.
   d. Sectioner cable.
3. Connect the amplitude display cable to the recorder.

SECTION III
OPERATION

IDENTIFICATION OF CONTROLS.

1. DISPLAY SWITCH *(S-401)*. This three position rotary switch is used to actuate the AMPLITUDE DISPLAY unit and to add a 10 db step of attenuation.

2. BASELINE SWITCH *(S-402)*. This dpdt momentary on-off switch is used to mark a base line on the graph paper.

NOTE

The following internal potentiometers are factory-adjusted and normally should not be changed unless necessititated by component replacement or serious misalignment of the equipment.

3. BIAS ADJUST *(R-424)*. This internal potentiometer adjusts the bias on the grid of *V-2* thereby controling the operating frequency of the multivibrator oscillator. This control is set so the tube will operate at 20 kilocycles in the *Sona-Graph* and 11 Kc in the *Vibralyzer*.

4. FREQUENCY ADJUST *(R-425a & b)*. This potentiometer is used as a vernier for *R-424* the BIAS ADJUST. The two pots are "rocked in" to provide an accurate (20 Kc or 11 Kc) oscillator output. The frequency depends on the analyzing unit in use.

OPERATING PROCEDURE.

1. Set up the equipment as described in Section II (Installation) and the interconnection block diagram.

2. Turn the DISPLAY switch *(S-401)* off. Record a sample of the sound to be analyzed in the normal manner.

3. Set the RECORD.REPRODUCE controls of the *Sona-Graph* or the *Vibralyzer* in the REPRODUCE position.

4. Set the Band Selector switch in the NARROW BAND position.

5. Set the MARK LEVEL switch to 7½.

6. The VU meter should indicate peaks of about -5 VU.

7. Turn the SECTIONER switch to the OFF position.

8. Rotate the display switch on the front panel of the AMPLITUDE DISPLAY unit to the ON position.

9. When the marking stylus is approximately 1¼" from the top of the sona-gram paper, depress the momentary baseline switch. This switch removes the input from the AMPLITUDE DISPLAY circuits thereby holding the frequency of the FM oscillator constant.

10. Release this switch immediately after the base line has been recorded on the paper. The amplitude vs time information will now be automatically written.

11. In the event that peaks of energy extend beyond the 1¼" space available on the sonagram paper the DISPLAY switch should be rotated to the -10 DB position. This will decrease the height of the amplitude display pattern by approximately 3/8 of an inch, and in most cases an uninterrupted amplitude tracing will result.

SECTION IV
THEORY OF OPERATION

The operation of the AMPLITUDE DISPLAY can be more readily comprehended by referring the functional block diagram and the schematic diagram. The basic circuits of the PLITUDE DISPLAY unit are:

1. *V-401* the amplifier rectifier.
2. The logarithmic detector.
3. *V-402* the FM oscillator.

1. AMPLIFIER RECTIFIER *(V-401)*. A 6SL7 duo-triode is used as an audio amplifier and a rectifier. The rectification is accomplished by shorting the grid and plate together effectively making one half of the tube a diode.

The output of the audio amplifier in the *Sona-Graph* or the *Vibralyzer* is applied to *V-401a*; which after amplification applies it to *V-401b* the linear rectifier The dc voltage at the cathode of *V-401b* is proportional to the ac voltage input at the grid of *V-401a* and varies according to the envelope of the sound sample in accordance with the rectifier characteristic and the time constants in the network associated with the cathode to ground circuit of *V-401b*.

2. LOGARITHMIC DETECTOR *(D-401, D-402, D-403)*. The dc voltage at the cathode of *V-401b* is applied to the logarithmic detector consisting of the three crystal diodes and the associated resistors. The diodes are biased, and the resistances chosen, so that the transfer characteristic closely approximates the logarithmic functions over at least a 24 db range. The output voltage from the logarithmic network is applied to the multivibrator *V-402*.

3. FM OSCILLATOR *(V-402 - 6SL7)*. The FM oscillator *V-402* whose frequency is a linear function of the voltage to which the grids are returned, is controlled by the dc voltage output from the logarithmic network. Thus, the frequency of operation of the multivibrator is a logarithmic function of the ac input to the grid of *V-401a*. This frequency, which varies with the envelope of the sound sample, is applied to the analyzing system in the *Sona-Graph* or the *Vibralyzer* and the record is produced in the usual manner.

SECTION V
MAINTENANCE

. TROUBLE LOCATION.

If the operation of the AMPLITUDE DISPLAY unit appears to be defective in any respect, irst ascertain that the cause of improper operation is not in the *Sona-Graph* or *Vibralyze* r the interconnecting cables. If a process of elimination indicates that the trouble originates in the AMPLITUDE DISPLAY make the following preliminary checks.

1. Make a visual check to determine that all filaments are lit and that there are no loose connections or obviously damaged components.
2. Check the voltage level at the ac line and the B+ input.
3. Check the operation of all AMPLITUDE DISPLAY circuits to determine the exact nature and extent of the defect.

The most common troubles encountered with the AMPLITUDE DISPLAY unit are weak or ective tubes, crystal diode failures, and occasional misalignments. The trouble lo- ion chart may be used as a guide to isolate the trouble to a particular circuit or ge.

NOTE: If V-402, the FM oscillator, is replaced it may be necessary to hand pick the replacement tube.

ALIGNMENT AND ADJUSTMENT.

1. Test equipment required for the adjustment of the AMPLITUDE DISPLAY:

   a. A high quality low range ac Voltmeter.

   b. A dc Voltmeter.

   c. Oscilloscope.

AMPLITUDE DISPLAY UNIT ADJUSTMENT

1. Set RECORD-REPRODUCE switch in REPRODUCE position.

2. Set shaping switch in FLAT position.

3. Turn BAND SELECTOR switch in NARROW position.

4. Turn SECTIONER switch OFF; set MARK LEVEL normal at 7½.

5. Turn AMPLITUDE DISPLAY switch ON.

6. Wrap paper around drum and mark it with a pencil 1¼" from top of paper.

7. Raise stylus to a point 1¼" from top of paper. Do not allow stylus wire to touch drum.

8. Connect ac voltmeter and/or an oscilloscope to *TJ-2*. This test jack is located at the rear of both the *Sona-Graph* and the *Vibralyzer*. Set ac voltmeter on the 10-volt range.

9. Set both pots *R-424* and *R-425a & b* (in AMPLITUDE DISPLAY unit) fully counter-clockwise.

10. Connect dc VM to *TJ-1*. Adjust *R-424* to obtain +1.0 volt at this point.

11. While depressing baseline switch, turn *R-425a&b* clockwise until first peak of 10 volts or more (as indicated on the ac voltmeter) appears on the oscilloscope.

    IMPORTANT: Disregard all peaks of less than 10 volts. If d-c VM reaches zero before 10-volt peak is reached, repeat steps 10 and 11.

12. Release the baseline switch. The pattern on the oscilloscope should be reduced.

13. Depress baseline switch again. Peak should reappear. Release stylus and pass through 1¼" setting made in step 6 several times, looking for a high peak at this point only.

14. If peaks DO NOT disappear on steps 12 and 13, repeat procedure.

15. Audio tests should be made producing baseline first, then releasing switch to allow pattern to mark.

16. Make a second display at -10 db position. Pattern should be identical to and 3/8" below first pattern.

TROUBLE SHOOTING CHART
AMPLITUDE DISPLAY CIRCUITS

SYMPTOM	PROBABLE CAUSE	REMEDY
No base line.	*S-402* defective.	Replace switch.
	S-401 defective.	Clean or replace.
Displaced base line.	35 Kc base line misaligned.	Adjust the base line in the *Sona-Graph* or the *Vibralyzer*.
No base line and no recorded information.	*V-402* defective.	Replace tube.
Base line but no amplitude information.	*V-401* defective.	Replace *V-401*.
	Either *D-401*, *D-402*, *D-403*, or all open.	Replace defective diode(s).
Base line has increased in frequency to the point that the signals are cut off.	Either *D-401*, *D-402*, *D-403*, or all.	Replace defective diode(s).

SECTION VI
PARTS LIST

RESISTORS: (UNLESS OTHERWISE SPECIFIED, ALL COMPONENTS ARE FIXED COMPOSITION, ½ WATT, 10% TOLERANCE RESISTORS.)

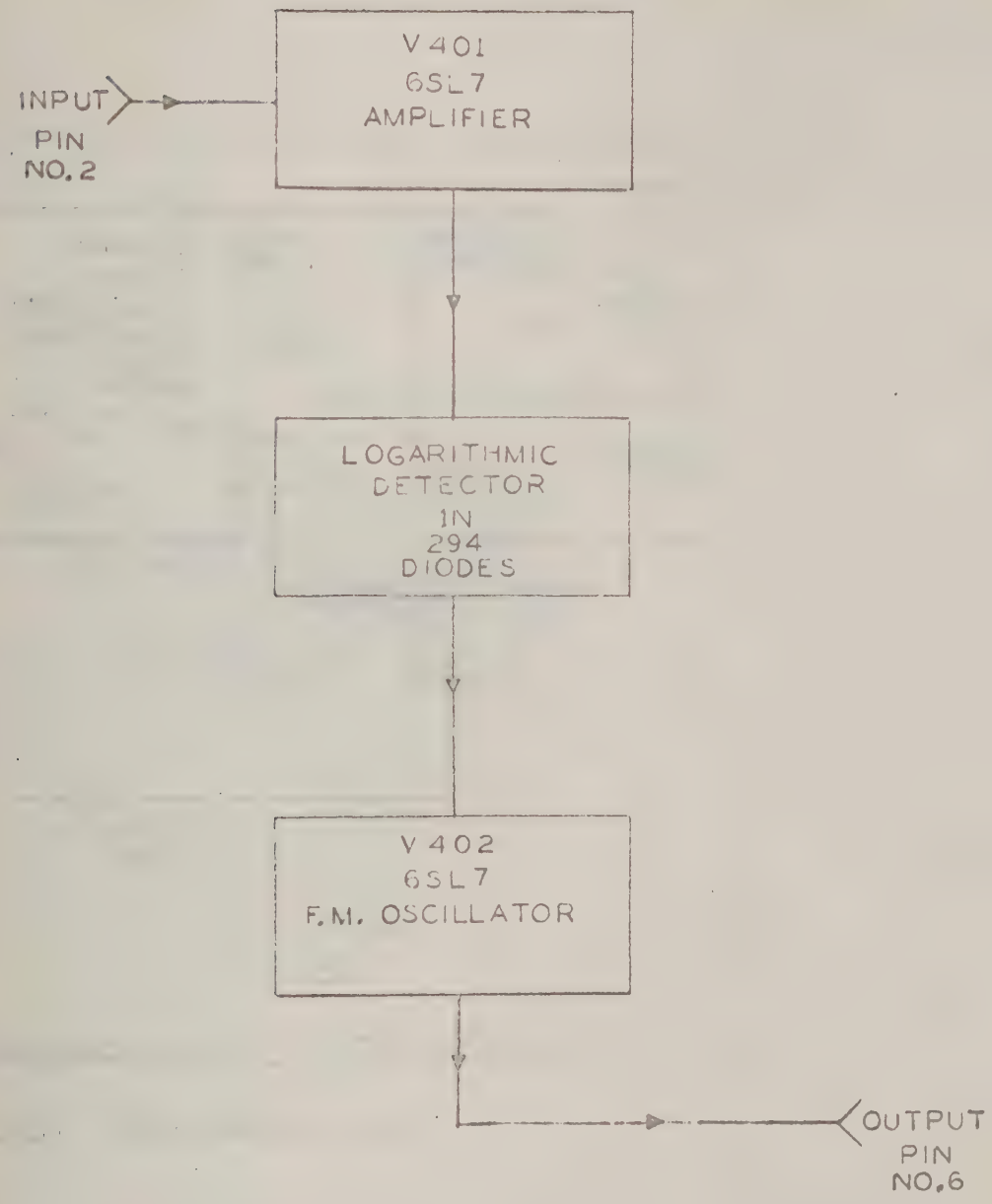
R-401	39K
R-402	18K
R-403	18K
R-404	1K
R-405	100K
R-406	47K
R-407	22K
R-408	10K
R-409	10K
R-410	10K
R-411	51K
R-412	51K
R-413	FACTORY SELECTED
R-414	1.2M
R-415	1.5M
R-416	5.6M
R-417	1.2M
R-418	82K
R-419	510K
R-420	39K
R-421	39K
R-422	39K
R-423	FACTORY SELECTED
R-424	50K, BIAS ADJ. POT. (INT.)
R-425	*a & b* FREQ. ADJ. POT (INT.)

CAPACITORS:

C-401	0.03μF
C-402	25μF
C-403	0.1μF
C-404	0.05μF
C-405	FACTORY SELECTED
C-406	FACTORY SELECTED
C-407	0.1μF
C-408	750μμF
C-409	20μF, ELECTROLYTIC

MISCELLANEOUS:

D-1	THRU D-3 1N294, HIGH FREQUENCY DIODES
J-401	SIX-PRONG JONES PLUG
S-401	THREE-POSITION ROTARY FUNCTION SWITCH
S-402	DPDT MOMENTARY ON BASELINE SWITCH
L-401	SPECIAL AUDIO COIL



OCK DIAGRAM FOR AMPLITUDE DISPLAY

FINISH:

SCALE:

NSIONS TOLERANCES UNLESS OTHERWISE SPECIFIED:
MAL DIMENSIONS ± .002 FRACTIONAL DIMENSIONS ± .005

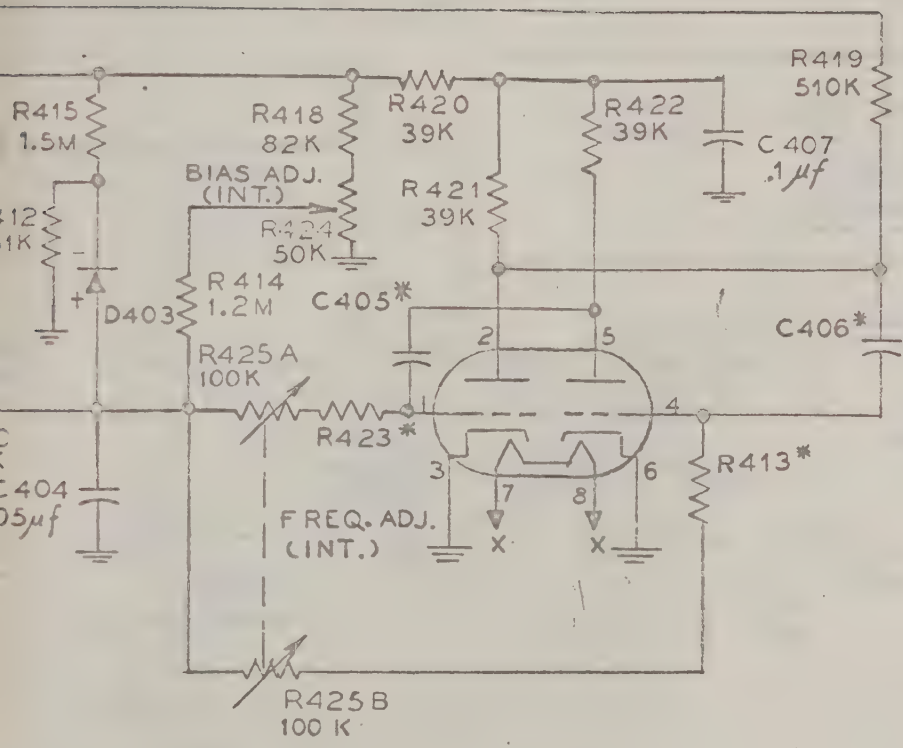
CHANGE	DATE	APP.

KAY ELECTRIC CO.
PINE BROOK, N. J.

DWN. BY Joseph Inger | DATE 9/11/57
APP. BY [illegible] | DATE 11/11/57

DWG. NO. KA 5457

KP-1001 11854



V402
6SL7

ATIC DIAGRAM AMPLITUDE DISPLAY

ELECTRIC CO PINE BROOK, N. J.

SCHEMATIC - AMPLITUDE DISPLAY

MAT.	FINISH:	SCALE:

DIMENSIONS TOLERANCES UNLESS OTHERWISE SPECIFIED:
DECIMAL DIMENSIONS ± .002 FRACTIONAL DIMENSIONS ± .005

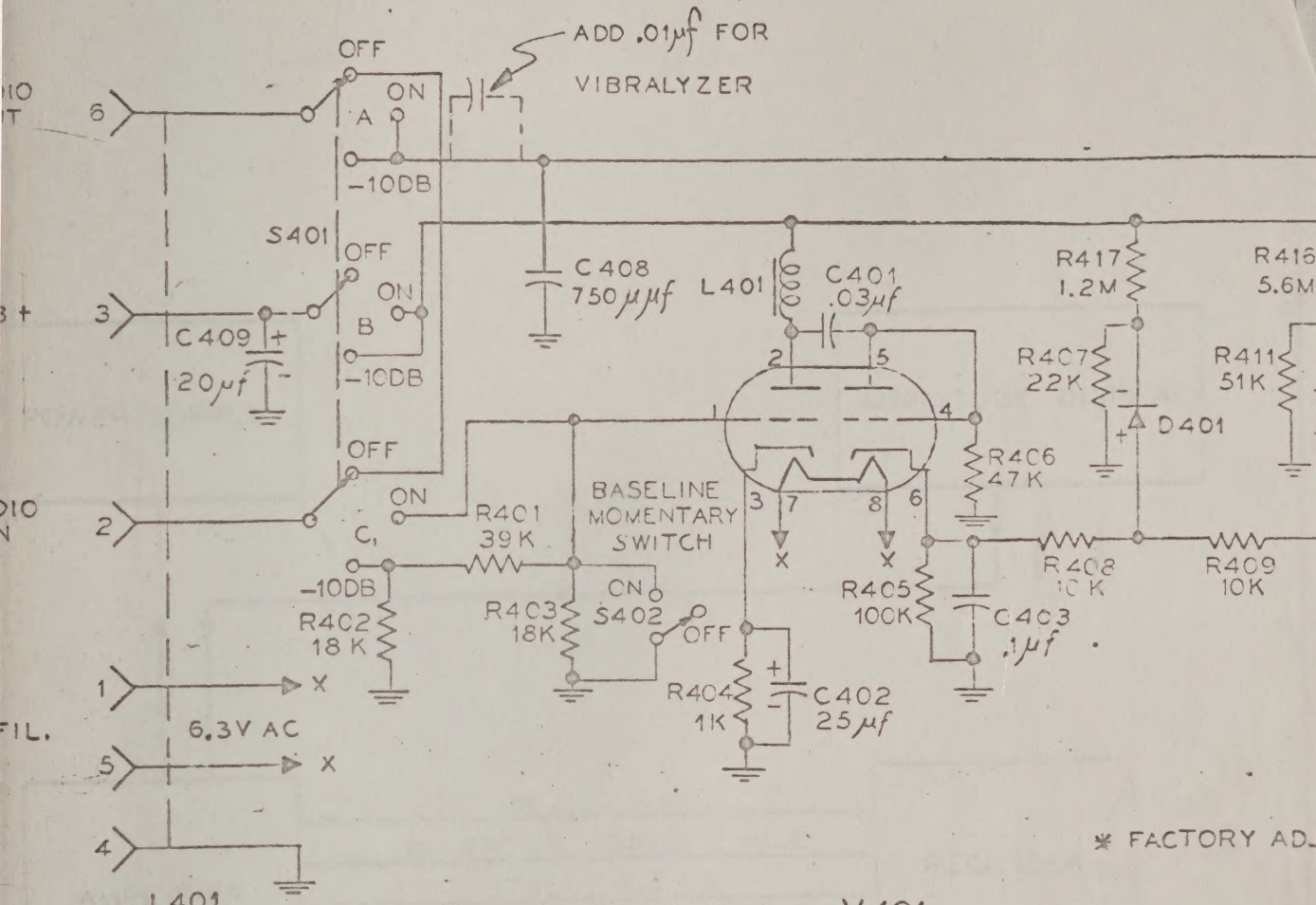
CHANGE	DATE	APP.
B Revised grid circuit	4-6-54	
C Added .01 μf Cer. Cond.	4-6-54	T.L.
D Revised instrument names used on	9/1/54	T.L.

KAY ELECTRIC CO.
PINE BROOK, N. J.

DWN. BY AW PIERCE DATE 12-6-54
APP. BY W O H DATE 12-6-54

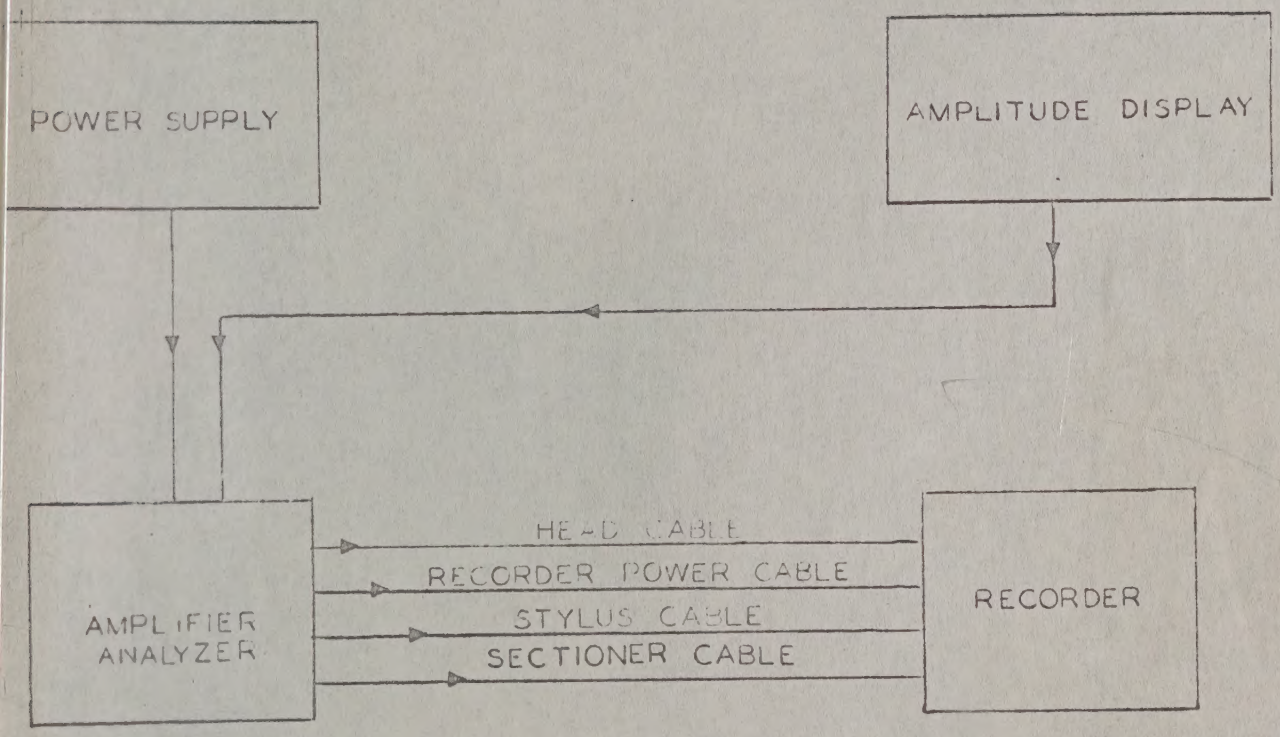
DWG. NO. KB 1473 C

FIG. 14 R64


ADD .01μf FOR
VIBRALYZER
OFF
ON
A
-10DB
S401
OFF
ON
B
-10DB
OFF
ON
C409
20μf
C408
750μμf
L401
C401
.03μf
R417
1.2M
R407
22K
D401
R411
51K
R406
47K
BASELINE
MOMENTARY
SWITCH
R401
39K
C1
-10DB
R402
18K
R403
18K
ON
S402
OFF
R404
1K
C402
25μf
R405
100K
C403
.1μf
R408
10K
R409
10K
6.3V AC
J 401
V401
6SL7

* FACTORY AD

ADD .01μf FOR
VIBRALYZER
OFF
ON
A
B
-100B
S401
OFF
ON
B
C
-100B
OFF
ON
C406
20μf
C405
150μμf
L401
C404
.03μf
R417
1.2M
R427
22K
D401
R426
47K
R425
100K
C403
.1μf
R402
1K
C402
25μf
BASELINE
MONENTARY
SWITCH
R421
39K
S402
ON
OFF
R423
18K
R422
18K
-100B
6.3V AC
J 401
V401
6SL7



INTERCONNECTING BLOCK DIAGRAM for AMPLITUDE DISPLAY

FINISH:

SCALE:

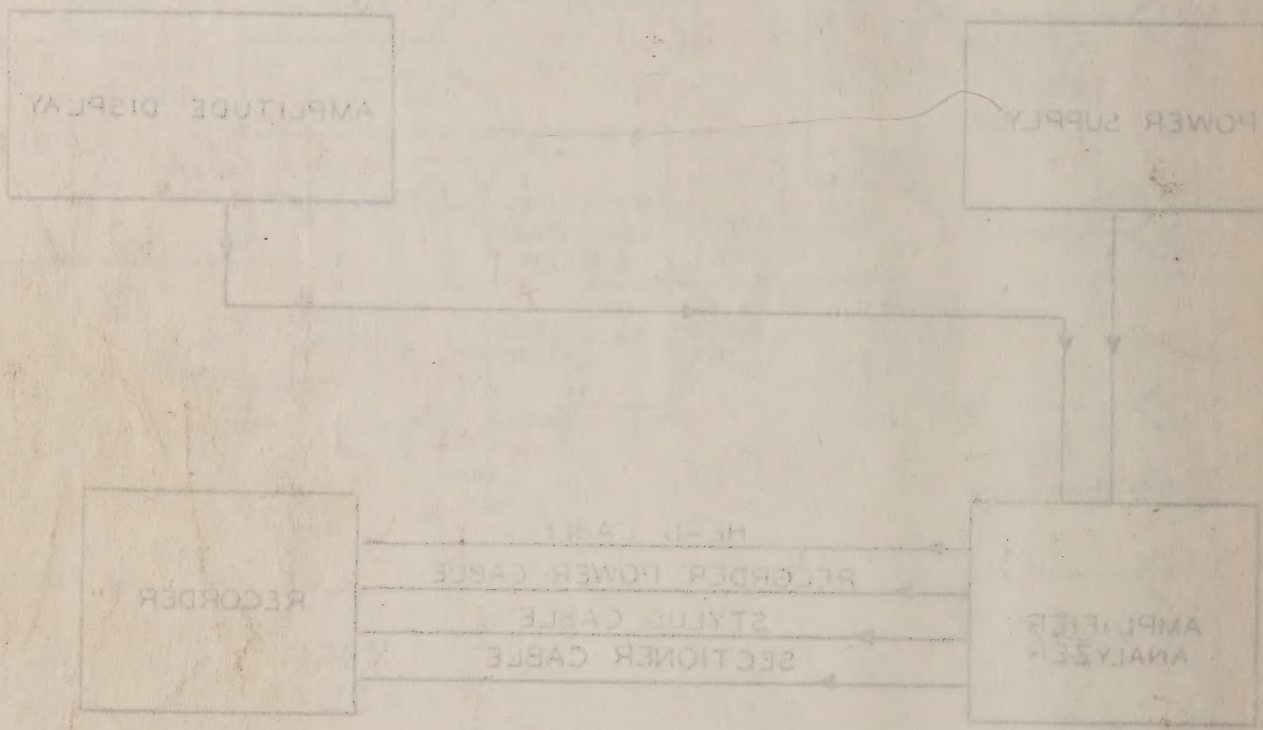
ENSIONS TOLERANCES UNLESS OTHERWISE SPECIFIED:
CIMAL DIMENSIONS ± .002 FRACTIONAL DIMENSIONS ± .005

CHANGE	DATE	APP.

KAY ELECTRIC CO.
PINE BROOK, N. J.

DWN. BY Joseph Pierce | DATE 9/19/57
APP. BY T Dougherty | DATE 9/19/57

DWG. NO. KA 5460


AMPLITUDE DISPLAY
POWER SUPPLY
RECORDER
AMPLIFIER
ANALYZER
RECORDER POWER CABLE
STYLUS CABLE
SECTIONER CABLE

92486